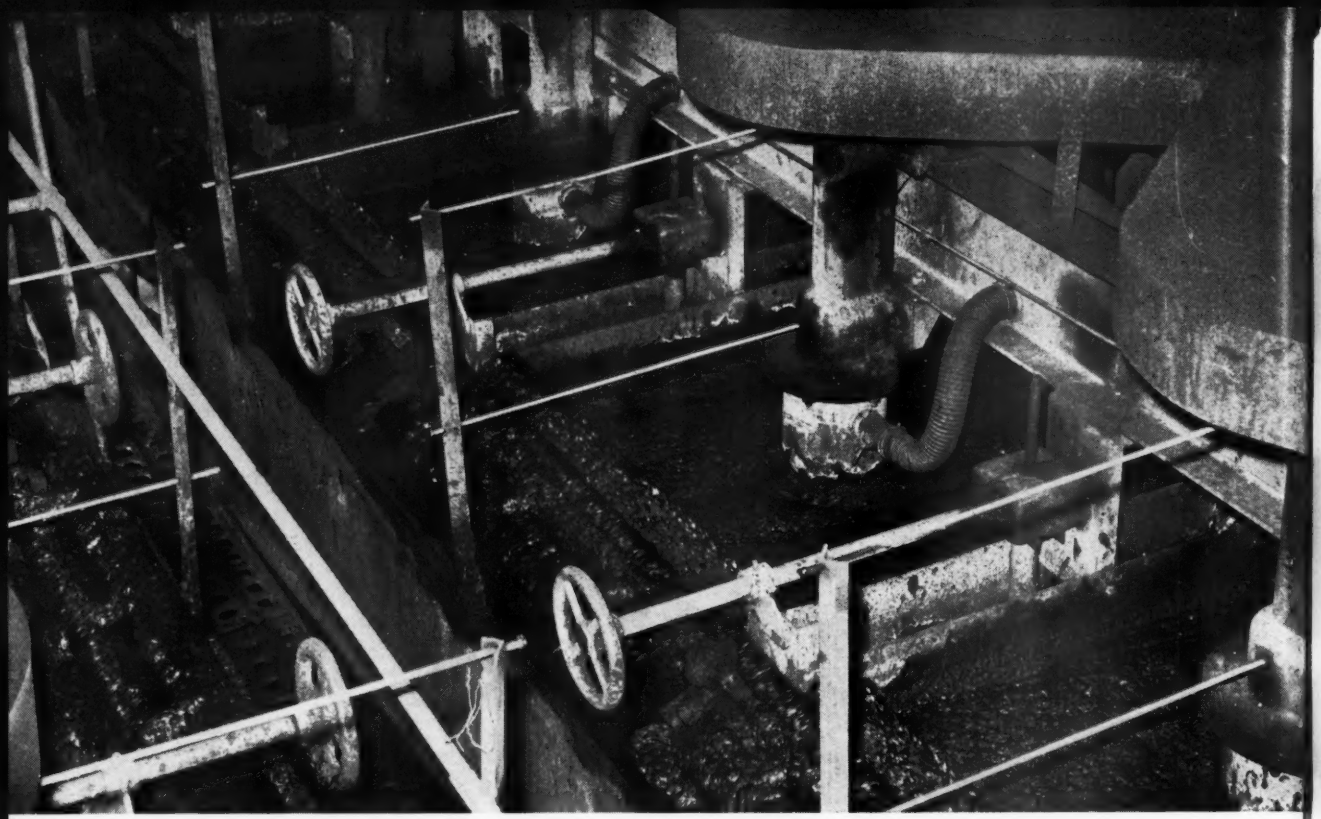
MINING CONGRESS JOURNAL

AMERICAN MINING CONGRESS

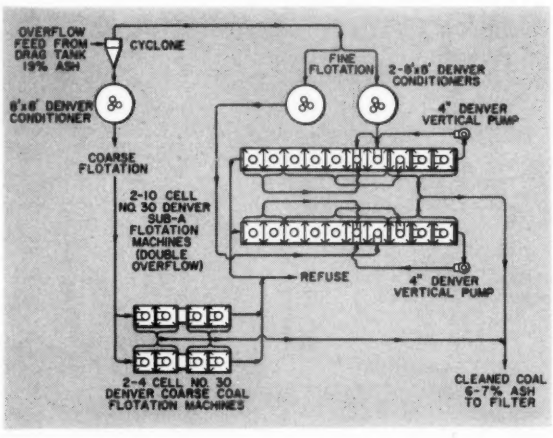
NOVEMBER 1961



Denver "Sub-A" Flotation at Kaiser Steel Corp.

... *Sunnyside, Utah Preparation Plant* ... Reduces Ash From 19% to 7%

Kaiser Steel Corporation's Sunnyside, Utah plant supplies metallurgical grade coal to the Kaiser Steel blast furnaces at Fontana, California. Coking coal from the Sunnyside, Utah mines is put through an improved coal preparation plant incorporating Denver "Sub-A" flotation to reduce ash content in the fine size fraction. Coal fines minus 28 mesh are reduced from 11 to 19% down to less than 7% ash.


OVERFLOW FEED FROM DRAG TANK 19% ASH
CYCLONE
FINE FLOTATION
2-8'x8' DENVER CONDITIONERS
6'x6' DENVER CONDITIONER
4" DENVER VERTICAL PUMP
COARSE FLOTATION
2-10 CELL NO. 30 DENVER SUB-A FLOTATION MACHINES (DOUBLE OVERFLOW)
REFUSE
4" DENVER VERTICAL PUMP
2-4 CELL NO. 30 DENVER COARSE COAL FLOTATION MACHINES
CLEANED COAL 6-7% ASH TO FILTER

High Tonnage—Low Cost Is Secret to Modern Plant Operation

Denver "Sub-A" Flotation and Denver Flotation Engineering are playing an increasingly important role in the profitability of coal cleaning as well as mineral recovery. Capacities range up to 1500 GPM per machine with high coal recovery and low ash content. Write for Bulletin F10-B81 and DENVER recommendations.

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CONTENTS

Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

Effect of Continuous Mining Equipment on Cleaning Plant Performance — 34
W. H. Noone

Developments in Taconite Blasting at Erie — 42
F. D. Bickel

Continuous Mining in Thin Seams — 48
Norman Yarborough

Disposal of Metallurgical Wastes — 52
Frank H. Day

Incline Drilling and Blasting — 57
Boris S. Kochanowsky

Wire Rope Spooling — Method and Practices — 63
Lonnie Thompson

The Brakeman Car — 67
E. J. Servant, Jr.

Job Hazards Analysis — 71
P. M. Wadsworth

Tensional Behavior of Floor Bolts in Advancing Longwall Coal Mining — 74
Richard J. Smith and George M. Pearson

Trends in Underground Rail Loading and Tramming — 78
James W. Clark

SPECIAL ANNOUNCEMENT

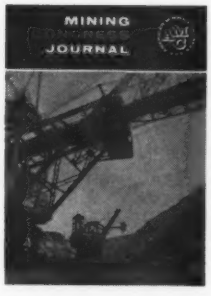
AMC 1962 Coal Convention — 95

DEPARTMENTS

Editorials — 33
Operators' Corner — 81
Wheels of Government — 82
Personals — 84
News and Views — 88
Report Corner — 94
Manufacturers Forum — 101

ON OUR COVER

Wheel excavator (foreground) and electric shovel strip overburden at United Electric Coal Companies' Cuba mine in Illinois. United Electric's production for its 1961 fiscal year was 4,377,000 tons of bituminous coal, the bulk of which went to utilities and industrial consumers.



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THIS MONTH

—MCJ Presents —and the AUTHORS

EFFECT OF CONTINUOUS MINING EQUIPMENT ON CLEANING PLANT PERFORMANCE

It is generally stated that continuous mining increases coal preparation costs. The author shows that often there is little difference between products from continuous miners and high speed conventional equipment. An outline is offered to enable accurate evaluation of the products from both methods to enable better planning for coal preparation. Page 34.

DEVELOPMENTS IN TACONITE BLASTING AT ERIE

Extensive experimentation at Erie Mining Company's Hoyt Lake, Minn., taconite operation, has resulted in the use of a free-running blasting agent that produces good fragmentation at low cost. The company has found that it can improve top breakage by building up the charge in the hole and practically eliminate secondary blasting through the use of short interval delays. See page 42.

CONTINUOUS MINING IN THIN SEAMS

Roof control and safety were improved by this new miner producing over 300 tons of coal per shift at Yancy, Harlin County, Ky. A weak, quick-breaking roof created a difficult mining problem. For details see page 48.

DISPOSAL OF METALLURGICAL WASTES

Chief waste products from metallurgical operations at Anaconda, Mont., are reverberatory slag, flue gases and dusts, mill tailings and effluent from a precipitation plant. The economics of smelter and mill operation dictate that these materials be disposed of cheaply and with maximum safety as described in the article on pages 52 to 56.

INCLINED DRILLING AND BLASTING

With newly designed blasthole drills it is possible to incline quarry and strip mine blastholes up to 40° from the vertical. This development has prompted interest in the potential advantages of blasting with inclined holes, an advance in mining technology which promises to reduce mining costs. The case for inclined drilling and blasting is presented on page 57.

(Continued on page 5)

W. H. Noone, superintendent of preparation, Semet-Solvay Division, Allied Chemical Corp., has had extensive experience in coal preparation for the coke market. He joined Allied after two summers' work during school years with the company. He has worked at the mine face in time study and supervision and held the title of research engineer before taking his present position.

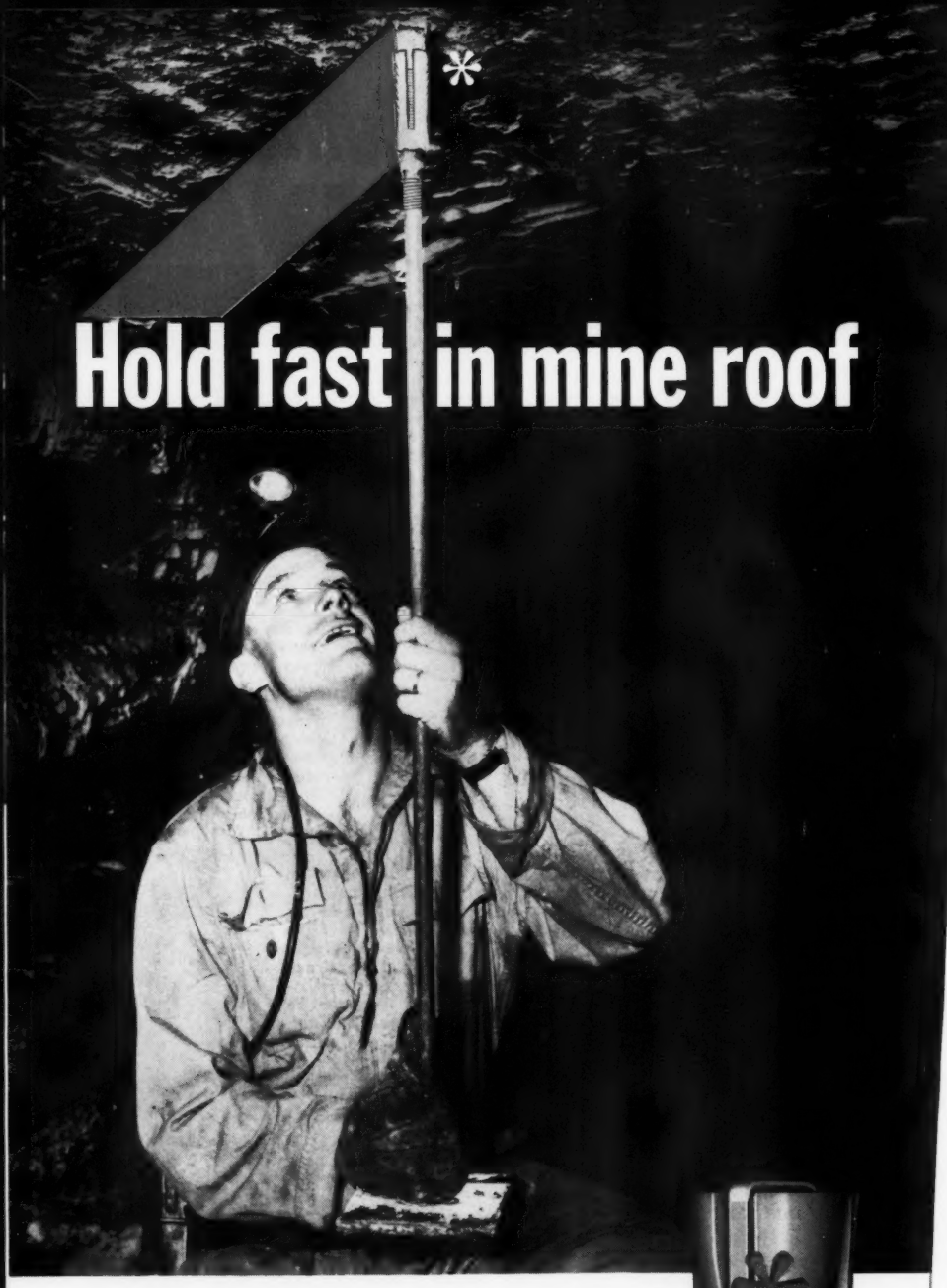
F. D. Bickel has had 33 years of experience in explosives and blasting work, prior to which he was employed on the Mesabi Range for 13 years. He has been a consultant on explosives and blasting since retiring as technical specialist for E. I. duPont de Nemours & Co. three years ago.

Norman Yarborough, general manager, Harlan Fuel Co. jointed the coal producer in 1937 as a coal loader. After service in World War II and attendance at the University of Tennessee, he joined Tennessee Coal, Iron & R. R. Co. as industrial engineer. He returned to Harlan Fuel in 1959.

Frank H. Day has been in the copper smelting industry for 33 years, taking his first job in 1928 as gas engineer for Cananea Consolidated Copper Co., S. A., an Anaconda Co. subsidiary in Mexico. Transferred to the Anaconda Reduction Department of Anaconda in 1956 as assistant general superintendent, he was promoted to general superintendent one year later.

Boris S. Kochanowsky, now with Pennsylvania State University, began his career by working as a miner while he completed his education at Freiberg, Germany. He has worked as a mining engineer and consultant in several countries. From 1946 to 1953 he was in Argentina as manager of coal mines and later professor of mining at the University of Cuyo.

Hold fast in mine roof



To:
Mr. Charles Maynard
Mine #3

Chuck:
This is the shell I talked to you about last week at the mine. Roof bolting is right up O-B's alley... they pioneered the use of expansion units... probably know more about them than anyone in the field.

Regards,
Jack

Ohio Brass 4-Way Expanding Anchors hold in both soft shale and hard rock

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- **DEVELOP TOP HOLDING POWER** with easy wrenching effort . . . 150 "foot pounds" of torque gives bolt tensions of 9000 pounds.
- **WORK IN CLOSE QUARTERS** . . . O-B engineers developed these anchors underground. Personal knowledge of mining problems enabled them to design units that are especially suited to your needs.
- **GET SERVICE** for your roof bolting problems . . . see your local O-B representative or write CANADIAN OHIO BRASS CO., LTD., NIAGARA FALLS, ONT. Ohio Brass Co., Mansfield, Ohio.

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10044-M

This Month (continued)

WIRE ROPE SPOOLING—METHOD AND PRACTICES

Proper attention must be given to wire rope design, fleet angle, tension, and spooling if a hoist is to do its work at the lowest possible cost. Thompson explains the importance of these factors in achieving smooth and efficient hoisting and covers basic methods of spooling in the article that starts on page 63.

THE BRAKEMAN CAR

After switching from battery-powered to trolley locomotives, Olga Coal Co. had to cut down on the size of its loaded trips because of less braking ability from the lighter locomotives. A number of grades in excess of three percent in favor of the loads compounded the problem. The answer was to add a magnetic-brake car which increased braking force by 75 percent. The article begins on page 67.

JOB HAZARDS ANALYSIS

An effective tool of accident prevention that has received too little attention by many companies is job hazards analysis. This technique points up the jobs where most accidents occur or where severity is high, making it possible to determine the most common causes and what corrective measures are needed. Page 71.

TENSIONAL BEHAVIOR OF FLOOR BOLTS IN ADVANCING LONGWALL COAL MINING

Floor bolting to prevent heaving has been tested in a National Coal Board mine in England. The trial was successful in controlling floor movement in this 22-in. seam of coal and the experiment indicates the method has potential. For details see page 74.

TRENDS IN UNDERGROUND RAIL LOADING AND TRAMMING

New track laying techniques, improved mine car construction, and automatic loading and dumping systems can cut costs and have encouraged a switch to rail haulage at some mines. The author discusses these advances and lists some good reasons for going to rail haulage in the article beginning on page 78.

—and the AUTHORS

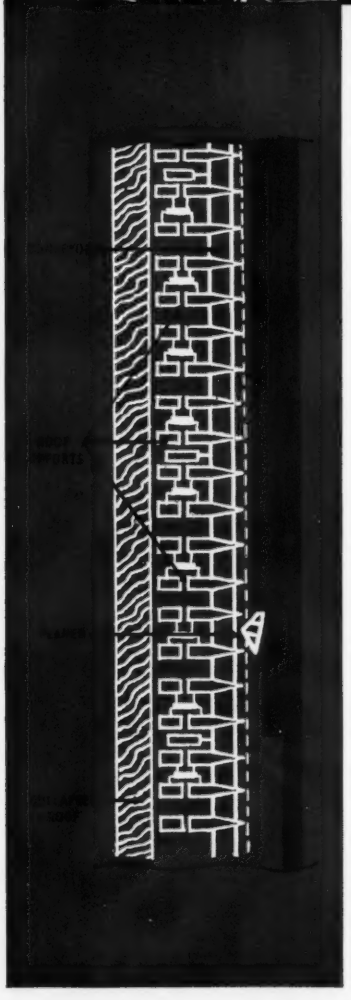
Lonnie Thompson has been with LeBus International Engineers, Inc., since 1950 and has been concerned primarily with the application of wire line spooling systems. For the past 10 years he has been in charge of all services in connection with wire line spooling applications in the capacity of chief sales and service engineer.

E. J. Servant, Jr., began his coal mining career in 1933 as a laborer and then mechanic for Pittsburgh Coal Co. at the Montour No. 4 and Westland mines. After attending the University of Alabama and serving in the Navy during World War II he returned to Pittsburgh Coal as shop engineer. In 1949 he joined Olga Coal Co., and since 1959 has been assistant general superintendent.

For the past four years P. M. Wadsworth has been safety director at Climax Molybdenum Co. He has been with Climax for the past 15 years, where he has also served as ventilation and industrial hygiene engineer and safety inspector. Before that he was a safety engineer in industry and Government agencies.

Richard J. Smith is a postgraduate research student and George M. Pearson is a lecturer in Mining Engineering. Both are associated with the Department of Mining Engineering, King's College, University of Durham, England.

James W. Clark has been manager of the Mining Machinery Division, Lake Shore, Inc., for four years and has been with the company since 1947. He has been instrumental in the development of many of the company's new products for mining, including skips, automatic skip loaders, cars, carloading and hoisting systems.



Westfalia Coal Planer Scores U.S. Success

During a full year's operation in a West Virginia mine, the Westfalia Coal Planer has demonstrated its ability to give high average tons-per-man production, low maintenance and dependable roof control. Operating in a mine with a 52-inch seam, the Westfalia Coal Planer is giving truly continuous mining along a 600-foot face. You cut production costs with the durable Westfalia long wall mining system because maintenance and repair expenses go down. You need no other roof supports or bolting. Cutting, drilling, explosives and other loading equipment are eliminated. Here is the only truly continuous mining method. It is the only successful, proven way to extract all the coal across working faces extending up to 800 feet—or even more. In thick or thin seams, the new Westfalia self-advancing, hydraulic roof supports, conveyor and planer all press continually against the face with a minimum of open area. Burnt or sticking top coal is removed automatically by the planer. Westfalia has proved itself in all major coal producing areas of the world with hundreds of installations. Now, continuous two-shift operation in West Virginia proves the Westfalia system to American operators. Consultation on engineering or equipment problems is readily available from our technical personnel with no obligation.

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Better Balanced Euclid C-6 gets more work done!

Owners of the "Euc" C-6 report that it's the best balanced tractor in the 200 h.p. class. Low center of gravity and close mounting of blades made possible by a rear-mounted radiator eliminate "nosing down" in heavy dozing work. The C-6 works easily on slopes where other crawlers can't be used because they won't hold on . . . and lower ground pressures let the "Euc" work in soft going that stops competitive tractors.

You've really got to see a C-6 at work to know what its excellent balance means in performance and productive capacity . . . your Euclid dealer will make arrangements, so get in touch with him soon.

C-6 *. . . lowest cost crawler in the 200 h.p. class . . . and most versatile by far!*

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Long-Airdox face preparation team sets fast pace for high-capacity mining systems

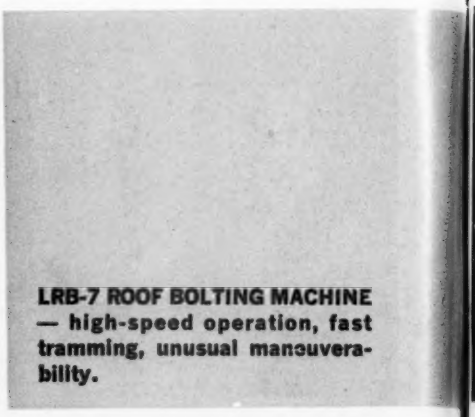
Here is how to have faster face preparation and higher production with lower costs—regardless of seam height. Take advantage of the superior speed and flexibility of this unique Long-Airdox face preparation team . . .

LRB-7 ROOF BOLTER. The most versatile and powerful machine of its type. Offers highest torque and thrust; most effective internal, through-steel dust collector; fast easy operation; low-maintenance hydraulic system.

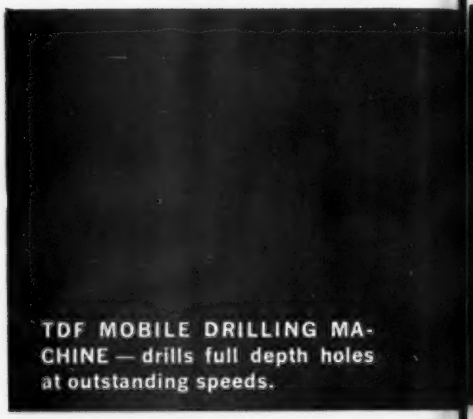
TDF DRILLING-SHOOTING MACHINE. Makes it possible for one man to handle both drilling and shooting in comparable time with either cutting or loading. "Rotary-Thrust" drilling principle applies thrust closer to face than any competitive machine. Three models for all seam heights and conditions.

AUTOMATIC AIRDOX SHOOTING. Faster than any other system and gives better product. Lighter weight automatic discharge tubes; sequence shooting of any number of holes in a single operation; and single-unit TDF drilling, multiple-shooting machine (which transports tubes and sequence valves) now make this system practical and economical for all conventional mining.

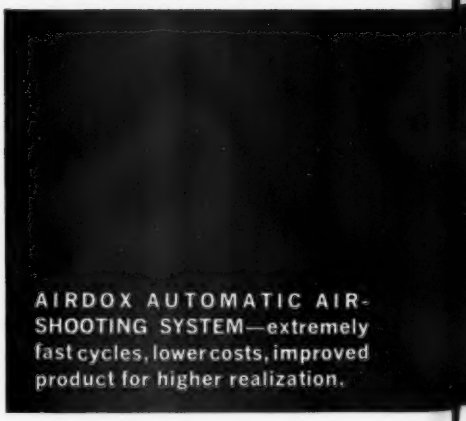
For facts and figures, write Long-Airdox, Oak Hill, West Virginia.



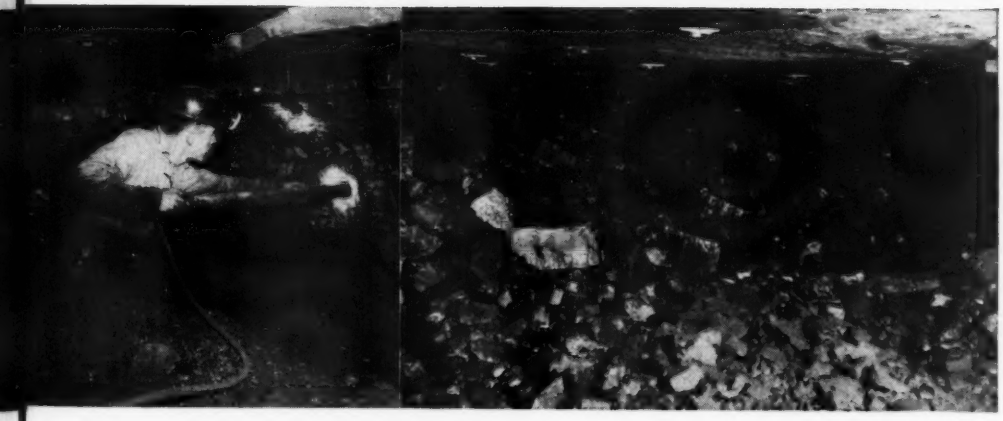
LRB-7 ROOF BOLTING MACHINE — high-speed operation, fast tramming, unusual maneuverability.



TDF MOBILE DRILLING MACHINE — drills full depth holes at outstanding speeds.



AIRDOX AUTOMATIC AIR-SHOOTING SYSTEM—extremely fast cycles, lower costs, improved product for higher realization.



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WHAT IS YOUR BEST BUY IN REUSABLE HOSE FITTINGS?

Compare

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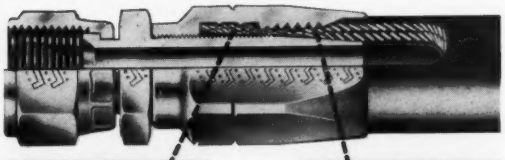
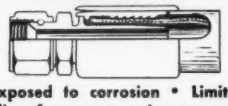
with three other types for the answer!

STRATOFLEX "SCREW-TOGETHER" TYPE



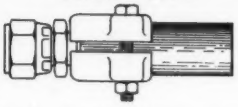
- Minimum envelope dimension
- No special tools required for assembly or disassembly
- Uses standard hose
- Complete reusability
- Pressure rating equal to burst of hose
- Uniform compression
- Long life proven in service

SLEEVE AND SEGMENTED TYPE



Wire exposed to corrosion • Limited reusability of segments • Large envelope dimension • Special tools and/or equipment required for assembly and disassembly • Non-uniform compression • Limited service history

CLAMP TYPE



Doesn't grip wire • Limited pressure rating • Large envelope dimension • Non-uniform compression • End of hose exposed to corrosion

NON-SKIVE TYPE

High assembly torques • Inconsistent grip of wire • Uses non-standard thin covered hose which has critical tolerances • Special tools required for proper assembly of hose to socket

SF5-1

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4 NEW MARION 11-YARD SHOVELS to attack TACONITE

Two major mining companies have each ordered two type 191-M shovels for their taconite operations in the toughest digging in North America. These machines weren't bought on price cuts or out-of-the-yard deliveries. They were bought because the type 191-M has proved, in actual competitive performance, what it can do in taconite, material so tough it will scratch diamonds.

It's no accident that more Marions mine taconite than all competitive makes combined. It's no accident that operating men recommend Marions, because operating men are judged on results.

And the records prove that Marion 6 to 13-yard mining shovels are most impressive in day-in, day-out production, availability, maintenance costs, and operating costs.

If you're more interested in production than price; if you're interested in sustained profitable performance, our mining specialists would like to talk with you about job-proved facts.

Progress begins with digging MARION

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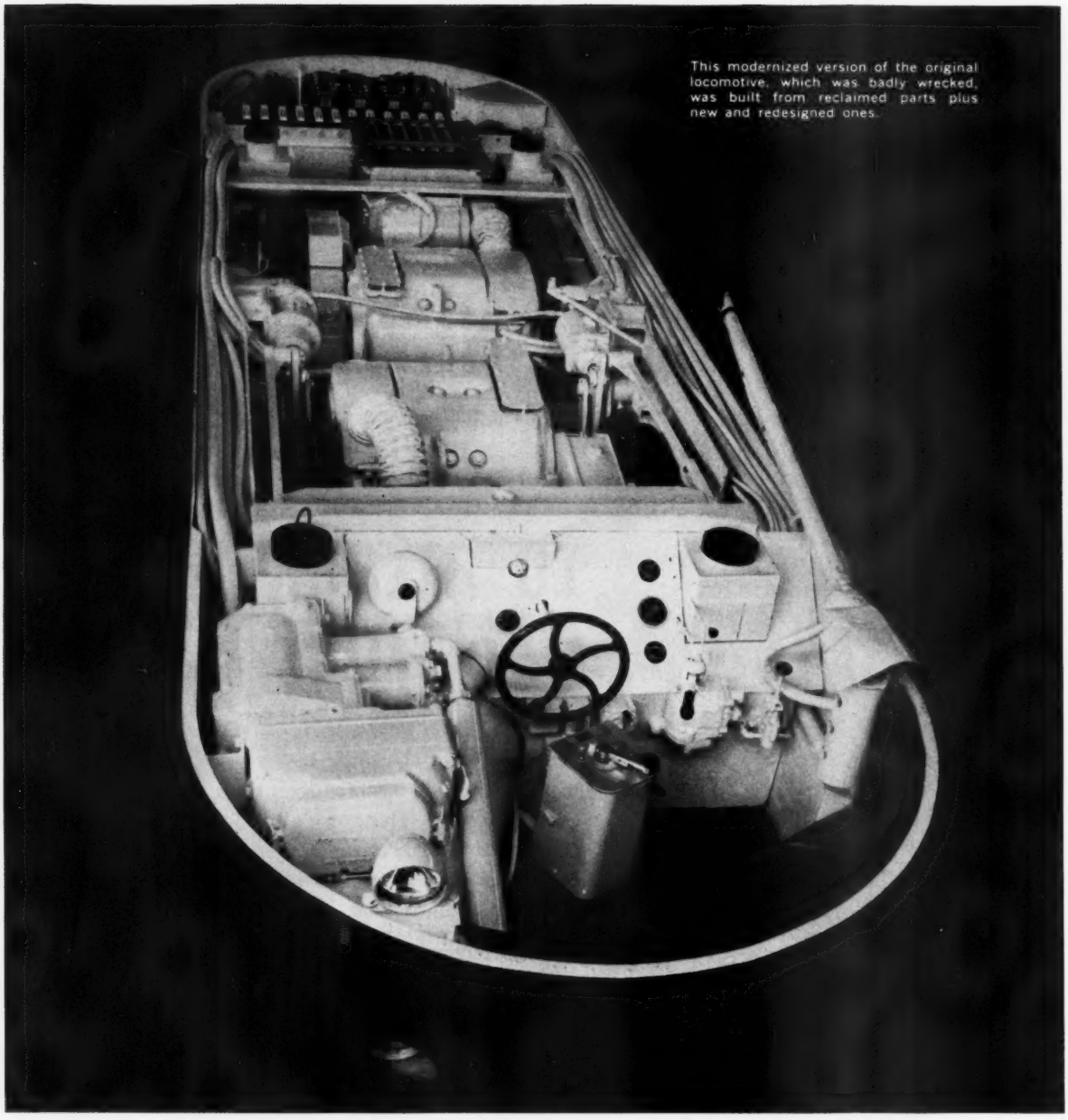
A Division of Universal Marion Corporation



This modernized version of the original locomotive, which was badly wrecked, was built from reclaimed parts plus new and redesigned ones.

NATIONAL'S COMPLETE REBUILDING SERVICE MODERNIZES MINE LOCOMOTIVE

This 24-ton locomotive was delivered to National's plant completely wrecked. Redesign and complete rebuild by National to new equipment standards included bumpers, air brakes, contactors, low voltage control system and other major modifications. National not only rebuilds mobile underground mining equipment but incorporates newest developments. Motor windings, for instance, have the latest and best grade insulation tailored by National to increase the work the whole locomotive can do. For unmatched service in mining machinery repairs, check your National field engineer or contact National Electric Coil... Bluefield, W. Va., or Columbus, Ohio... or National Electric Service Corporation . . . Harlan, Kentucky.

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McGRAW EDISON

New Steel Idler Design Improves Belt Training On

JOY LIMBEROPE® CONVEYORS

New 36" Joy Limberope Conveyor in West Virginia mine is 1500 feet long, provides main haulage for two sections.

New Joy Limberope rope belt conveyors maintain excellent belt training almost indefinitely, without attention. Unique new method of clamping the bracket locks it to the rope so tightly that even a blow from a sledge hammer will not move it. Once in alignment, the new Limberope conveyor will maintain alignment against any normal jarring.

The new three-roll steel idlers are offset for free-running and ease of lubrication and servicing. Installation is quick and easy. Brackets maintain exact rope-to-rope distances, and height can be adjusted readily with hanging chain supports.

Joy also offers other types of steel and neoprene idlers for both underground and aboveground applications. For complete information on the latest in rope belt conveyors, write for Bulletin 2652-3.

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY

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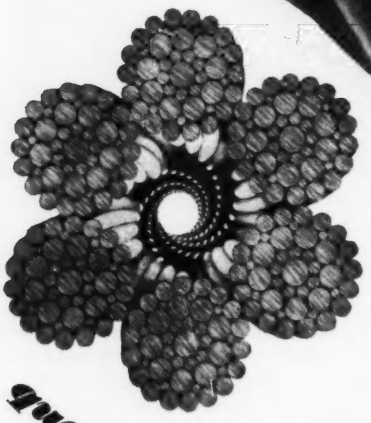
We put a lot of work into it — You get a lot of work out of it



quality inside and outside

Here are two "close-ups" of Roebling Royal Blue Wire Rope which show in part where your savings come from . . . uniformity of structure. Invisible, but equally important, is Royal Blue's *extra* high tensile strength. All the way through, Royal Blue pays off for you on every kind of wire rope job. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, New Jersey.

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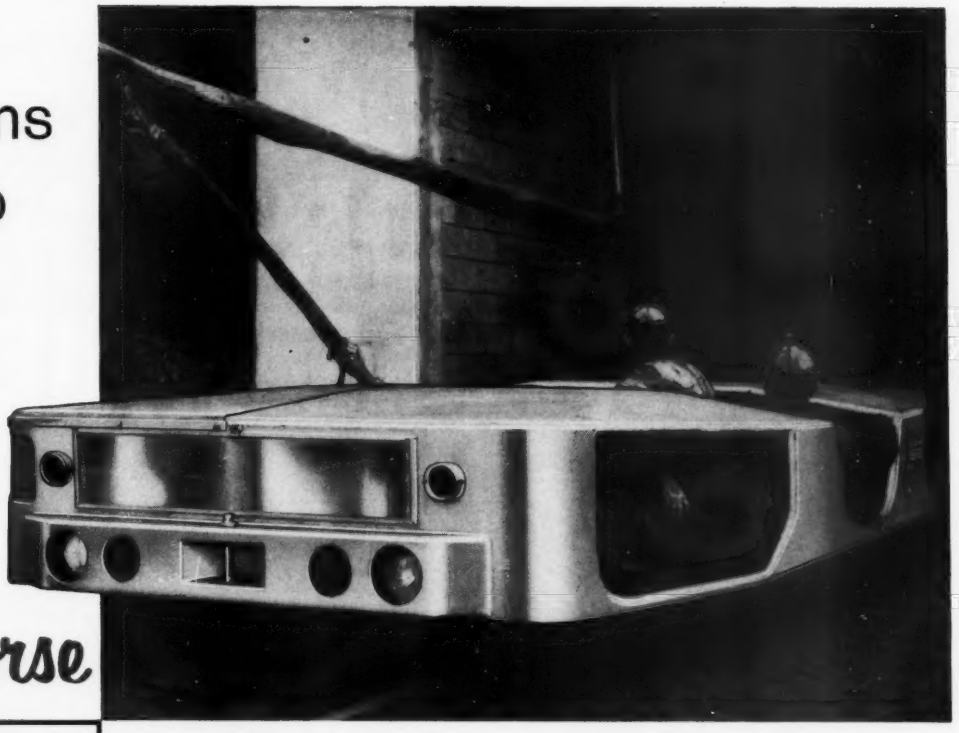
Reasons why so many mines use the

Lee-Norse



LOW mine portal bus

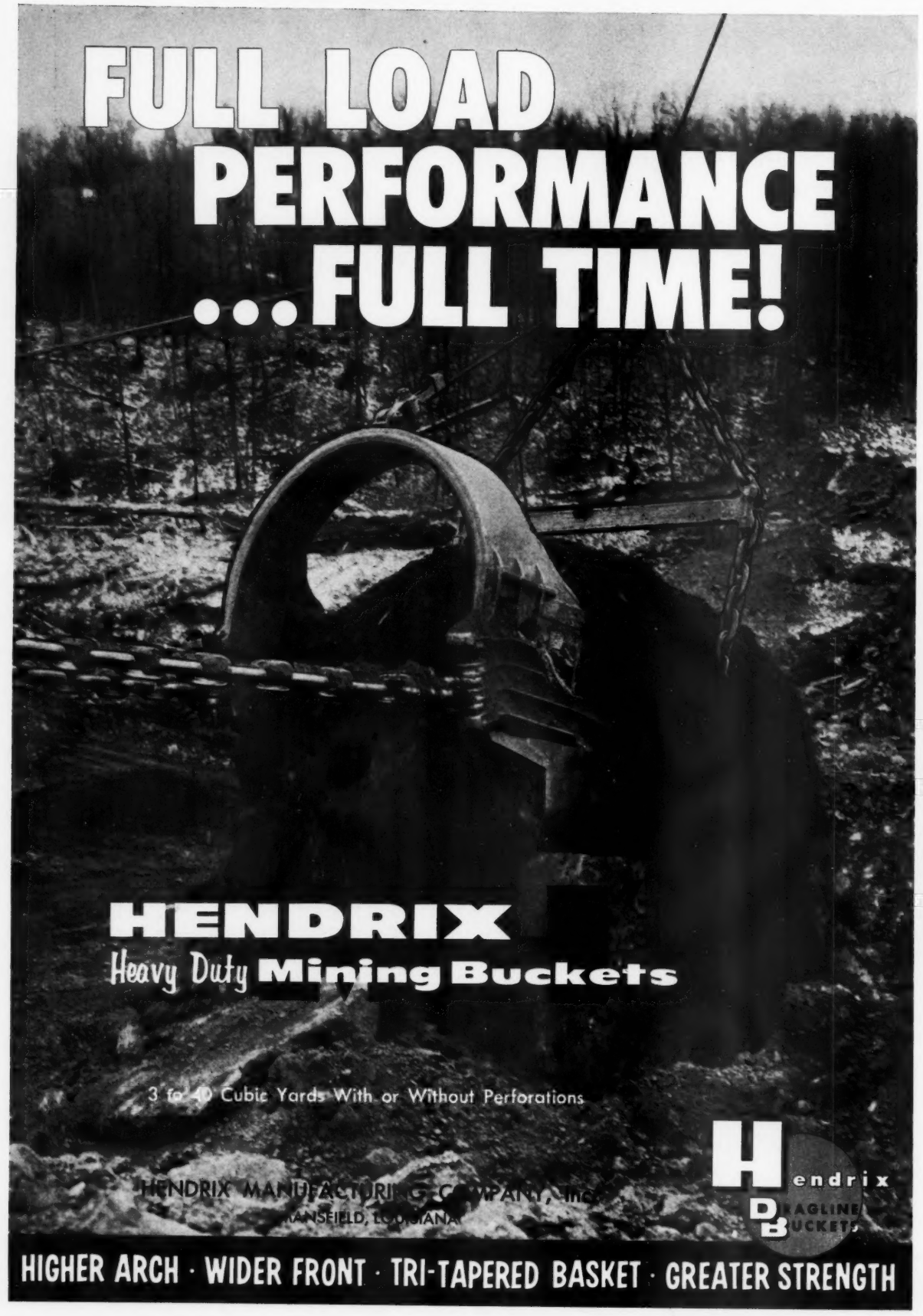
1. FAST—Cuts portal to portal time as much as 50%.
2. STREAMLINED—Transports 11 to 13 men in safety and comfort in low seams.
3. SAFETY—Exclusive split-roof allows operator full directional vision—trolley pole easily reached. Quick acting hydraulic truck-type brakes on each axle and on the traction gearmotor. Independent mechanical hand parking brake each axle.
4. POWERFUL—Self-propelled by sturdy traction-type 15 HP gearmotor (250 or 550V—DC).
5. RUGGED—Quality built to withstand the hard usage of 'round the clock mining!
6. LOW MAINTENANCE—Simple design—easy accessibility.
7. OPTIONAL FEATURE—Electric dynamic brakes for plus safety on severe grades.

LN

Lee-Norse Company

CHARLEROI, PENNSYLVANIA

Specialists in Coal Mining Equipment


FULL LOAD
PERFORMANCE
...FULL TIME!
HENDRIX
Heavy Duty Mining Buckets
3 to 40 Cubic Yards With or Without Perforations
HENDRIX MANUFACTURING COMPANY, Inc.
MANSFIELD, LOUISIANA
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DRAGLINE BUCKETS
HIGHER ARCH · WIDER FRONT · TRI-TAPERED BASKET · GREATER STRENGTH

THE STRENGTH OF A BELT IS IN THE CARCASS!

and

Scandura

SOLID WOVEN PVC

has the highest tensile carcass of any belting in the mining industry

Results:

- PROVED SERVICE RECORD!
- NO FASTENER PULL-THROUGH!
- LONGEST CENTERS!
- UNEQUALLED TOUGHNESS!

It's an easily-demonstrated fact: SCANDURA has the strongest, most densely-woven carcass of any solid-woven or ply-type belt. This superiority serves you best in *every* measure of belting performance—dollar by dollar, year by year! Your National Mine man has the facts. *Call him.*

550 feet per minute is normal for SCANDURA on this rope conveyor

National Mine Service Company

Koppers Building Pittsburgh 19, Pa.

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This is
AMERICAN OIL COMPANY
in action

BY C. L. "CHARLIE" BROWN

About the Author. Charlie Brown is a lubrication specialist. His eleven years of experience in such work are only part of his qualifications. He majored in math and physics at Eastern Illinois State College and he has completed the Company's Sales Engineering School.

★ ★ ★

On the coal washing equipment at Crown Mine they were experiencing trouble with the lubrication of the air valves. Because the grease wasn't getting in to do the lubrication job, valves were sticking. Working with the General Top Foreman, we recommended RYKON Grease "R." This is a grease with unique properties. It flows like an oil, but the shearing action exerted by working pressures irreversably converts the fluid to a grease. Since switching to RYKON Grease "R" in the washing jigs there's been no grease leakage and the valves work freely.

This is one instance where we helped solve a problem. But our big job was surveying the lubrication needs of the preparation plant at the time it was built. This was done and lubrication recommendations were made to insure the most economical operation of the plant. We solved the mine's problems on inventories, too. With warehouse facilities only 12 miles from the plant, we're able to keep supplies of needed products available for immediate delivery. This cuts inventory costs and provides insurance against having to wait for deliveries.

★ ★ ★

Is this the kind of product performance and service you're looking for? Get it by calling the American Oil Company office near you.

Quick facts about **RYKON® Grease "R"**

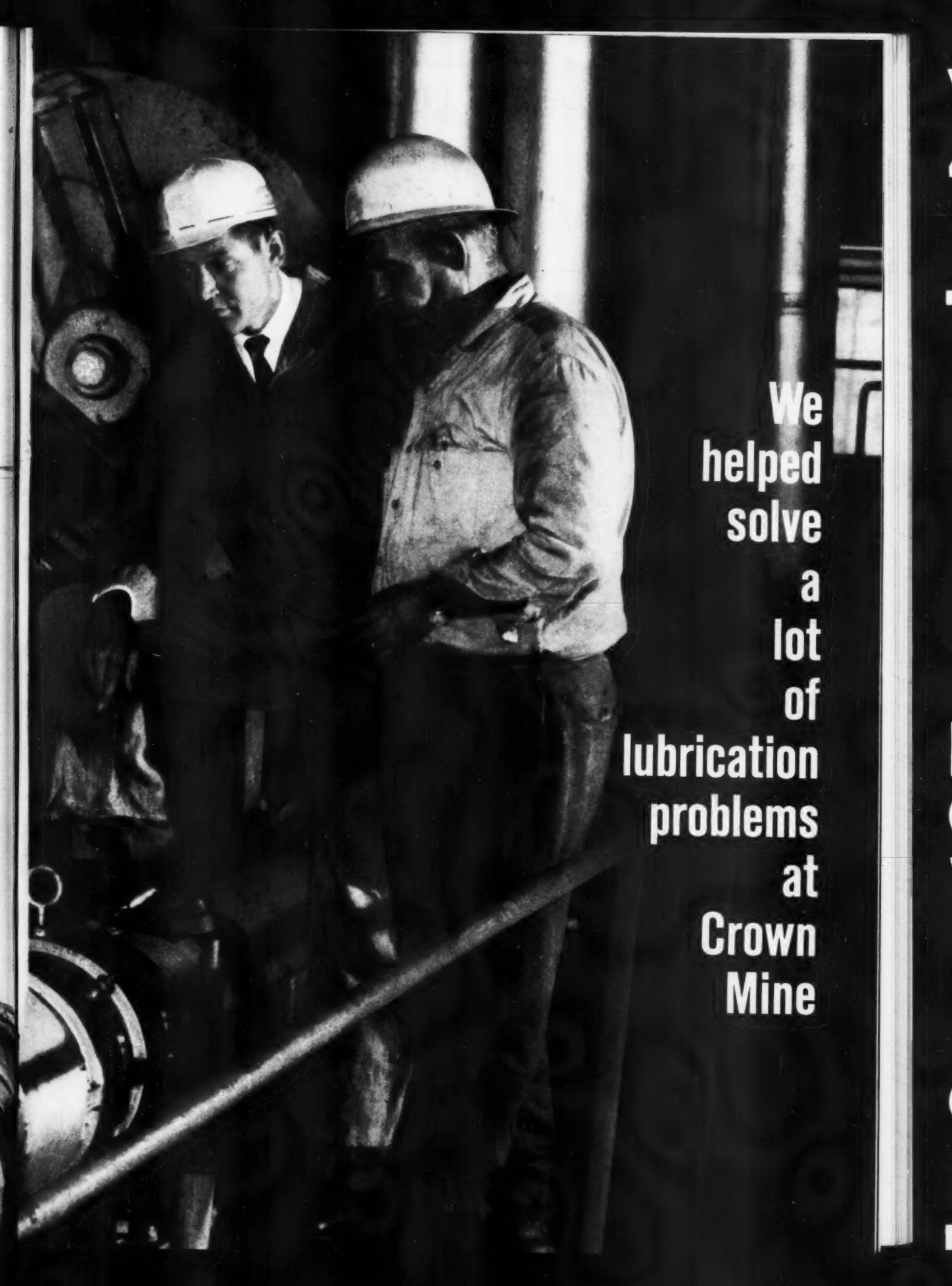
- Flows like an oil. Under shearing action converts to grease.
- Resists moisture and protects against corrosion.
- Stable under high temperatures.
- Mechanically and chemically stable.

AMERICAN

AMERICAN OIL COMPANY

910 SOUTH MICHIGAN AVENUE
CHICAGO 80, ILLINOIS

Get in the plant and find out how things are going. American Oil representative Charlie Brown does this. Here he discusses lubrication with Bob Boyett (right), Crown Mine General Top Foreman.

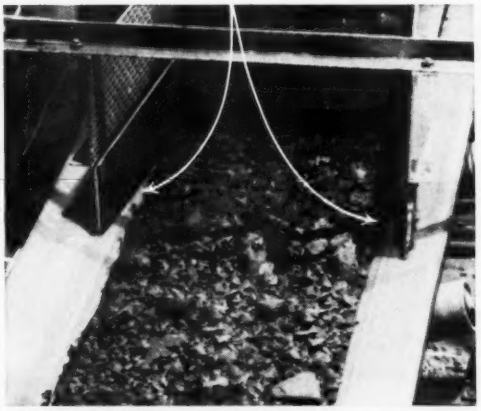

We
helped
solve
a
lot
of
lubrication
problems
at
Crown
Mine

AT THE HEART OF INDUSTRY...

Coal crosses a river on a 3,870-foot US Conveyer Belt at Jones & Laughlin's La Belle, Pa., preparation plant, one of the world's largest. The US Belt, supported by the world's longest belt-conveyor bridge, has been carrying run-of-mine coal since 1948 without a breakdown. In this time it has carried over 50 million tons of coal.

CB 106

Wherever the coal industry operates, you'll find US Industrial Rubber Products and engineers helping automate the mining, handling, and utilization of coal, making it the economical energy producer it is.

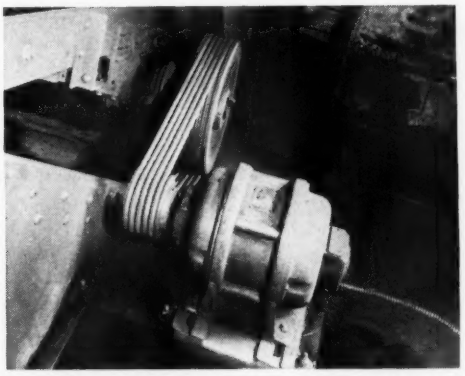


No more spilling or gouging when your conveyors are protected by U.S. Royalite® Skirt Boards. These Skirt Boards won't groove conveyor belt covers or pick up abrasive materials and moisture. Used at loading points, they center the load, insure proper training, prevent uneven belt wear, add years of life to belts.

SK 101

The first perfected interwoven coal mine belt, the U.S. Burro® Conveyor Belt is tough all the way through, is safe, is fire resistant. Besides exclusive engineered stretch control, this belt has the widest operating temperature range, highest edge and lengthwise rip resistance, assures perfect troughability, and...is low in cost.

CB 105



Known for maximum reliability, safety, and profit, U.S. Royal V-Belts provide top efficiency, exceptional length stability, uniformity and long service life on all types of drives. You'll profit from the driving power of U.S. Royal V-Belts on conveyor, elevator, and loading-boom equipment; crushers, breakers, dryers and pumps; ventilator and cooling fans.

VB 109

For every industrial rubber product need, turn to US. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings... custom-designed rubber products of every description. Discover why U.S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U.S. Rubber Distributor or contact US directly at Rockefeller Center, New York 20, N. Y.

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OF INDUSTRIAL RUBBER PRODUCTS

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The right Macwhyte

reduces wire-rope wear

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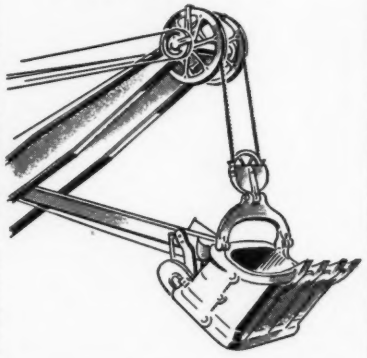

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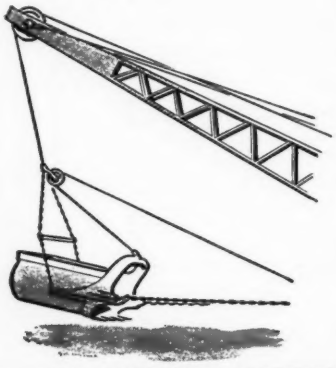

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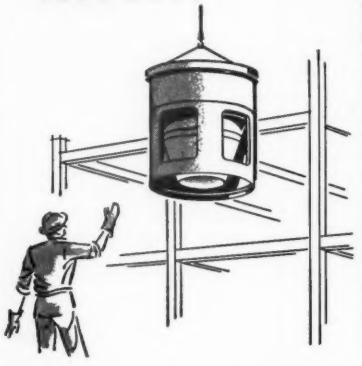

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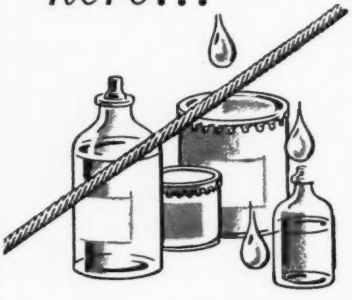

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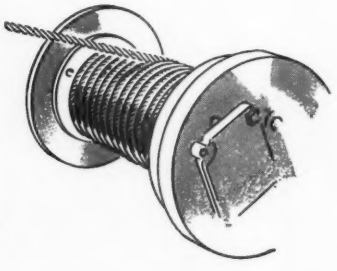


...and it cuts costs

Ask about Macwhyte's new 7-FLEX® wire rope

The right Macwhyte, PREformed and internally lubricated, gives you the combination of wearing qualities your equipment demands. Macwhyte has more than 60 years' experience in meeting the needs of open-pit and underground mining equipment . . .

Strippers	Incline Hoists	Underground Scrapers	Conveyors
Loading Shovels	Shaft Hoists	Wagons	Car Pullers
Draglines	Blast-hole Drills	Loaders	Tuggers
Shaft Sinking	Scraper Loaders	Mining Machines	Slushers

Macwhyte distributors will give you the right Macwhyte. Circular 6025 tells why you save with the right wire rope on your equipment. It's free upon request to Macwhyte Company, 2900 Fourteenth Avenue, Kenosha, Wisconsin (or authorized distributor). 258

MACWHYTE Wire Rope COMPANY

Wire Rope Manufacturing Specialists Since 1896

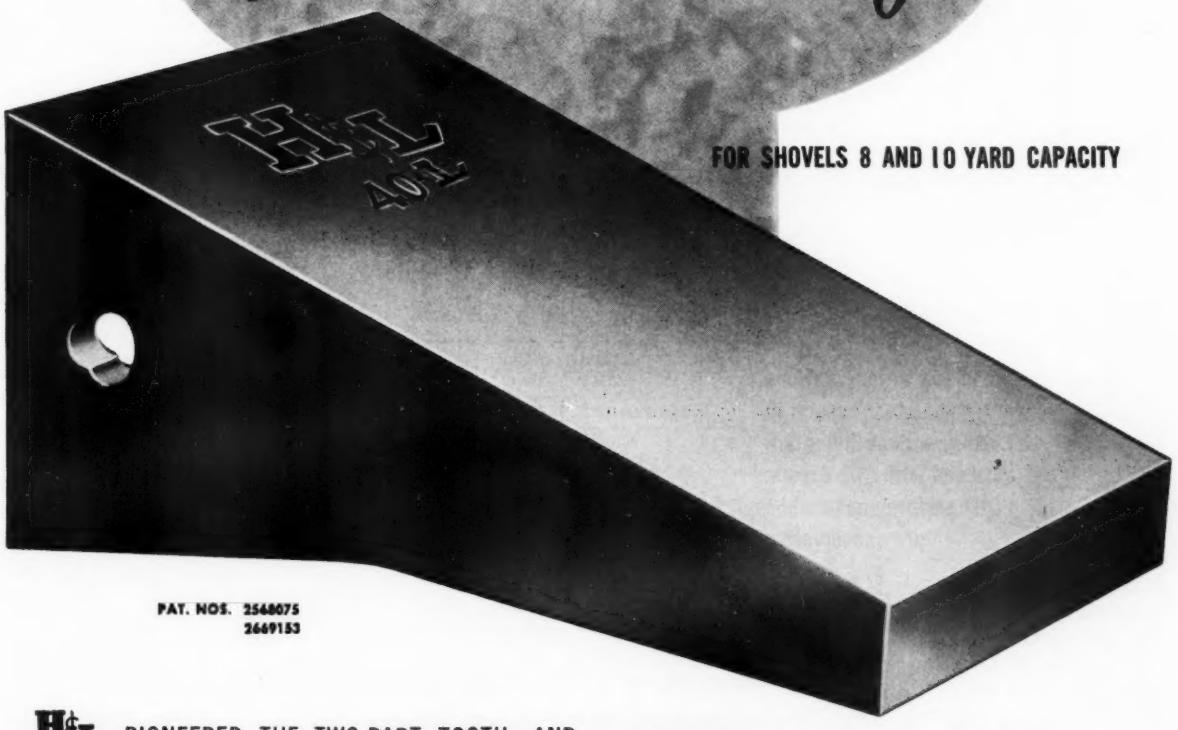
H&L *Teeth that really dig!*

THE ALL FORGED SUPER STEEL 40-L POINT

HARDER—WEARS LONGER—NO BREAKAGE, ALL FIELD REPORTS SAY THE SAME, THE 40-L POINT GETS...

PRIME YIELD IN

Payload Profits



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H&L PIONEERED THE TWO-PART TOOTH, AND FOR OVER 31 YEARS HAVE SPECIALIZED IN THE MANUFACTURE OF QUALITY DIGGING · POINTS, WITH A WORLD WIDE RECORD OF SUPERIOR PERFORMANCE.

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FOR COMPANIES OF EVERY SIZE

CMI COAL DRYERS

The Two Most Popular Sizes of CMI Continuous Centrifugal Coal Dryers

MODEL 36 (above)—65 TPH
COMPACT 26 (left)—20 TPH

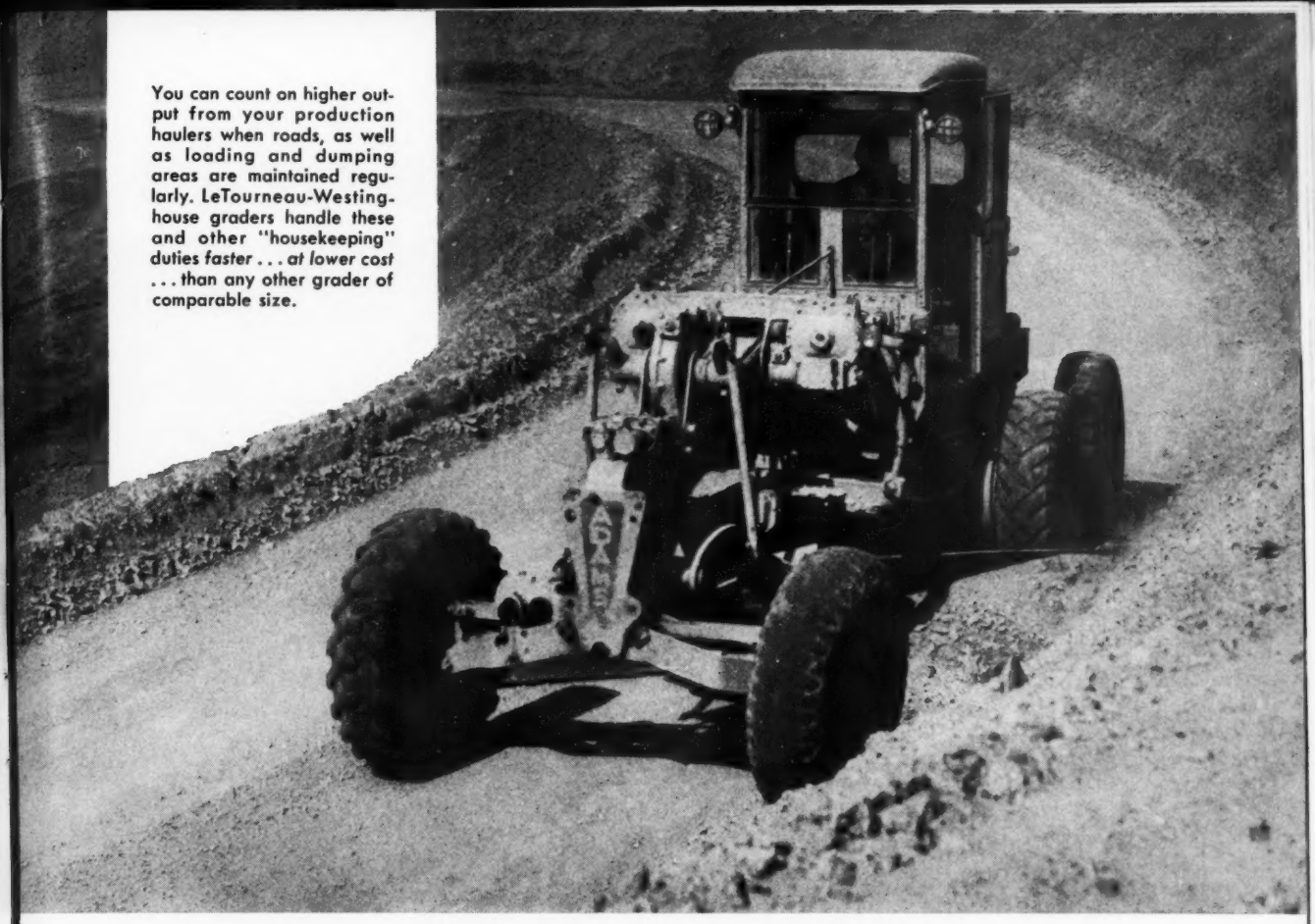
Hundreds of installations prove that best results in centrifugal coal drying are obtained with CMI Dryers. CMI performance claims are conservative and correct.

GENERAL SPECIFICATIONS	COMPACT 26	MODEL 36
Conservative rating with feed of ¼ x 0 product at 35% surface moisture	20 tph	65 tph
Percent recovery of product	over 90%	over 90%
Percent surface moisture of discharge product	under 6%	under 6%
Horsepower consumption	10-15 hp	50 hp
Total machine weight, including motor	4700 lbs.	13,000 lbs.
Floor space required	59" x 59"	71" x 76"
Overall machine height	52"	80"
Motor specifications	15 hp; 1800 rpm	50 hp; 1800 rpm

For complete information, write for literature.

CMI **CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.**

146 PRESIDENT STREET • ST. LOUIS 18, MISSOURI



You can count on higher output from your production haulers when roads, as well as loading and dumping areas are maintained regularly. LeTourneau-Westinghouse graders handle these and other "housekeeping" duties *faster . . . at lower cost* . . . than any other grader of comparable size.

A practical way to speed "routine" road maintenance

Most of your grader work is probably a lot like that pictured here . . . "routine" maintenance chores. They require nothing unusual in the way of power, little special equipment, and ordinarily they can be handled without "paper work." But, the *difficult* thing about these jobs is that there are so very many of them to do all of the time!

That's why many mines and quarries choose LeTourneau-Westinghouse Model 440 and 550 graders for this type of work. Owners prefer them because these LW machines are *faster* than all other graders in their power class . . . they can *complete* more assignments in less time.

25% faster travel than average

Consider travel speed, for instance: The "440" and "550" get from job-to-job at speeds to 25.2 mph. *That's 25% faster than the average top speed of any other "medium-size" grader on the market.* And with a top *reverse* speed of 13.2 mph, these LW graders are a full *59%* faster than the average!

The "440" and "550" *work* faster, too. With 8 forward speeds and 4 reverse, your operators have more full-power speeds to choose from, and on most operations they work from 1 to 3 mph *faster* per pass.

MPH advantages, however, are only *one* reason why LW motor graders get more work done faster. To understand their true value it will be worth your while to see an LW operate at your pit. We will be happy to demonstrate the size grader that fits your needs. 7 models, 85 to 190 hp. Ask for complete details.

G-2344-MQ-1

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

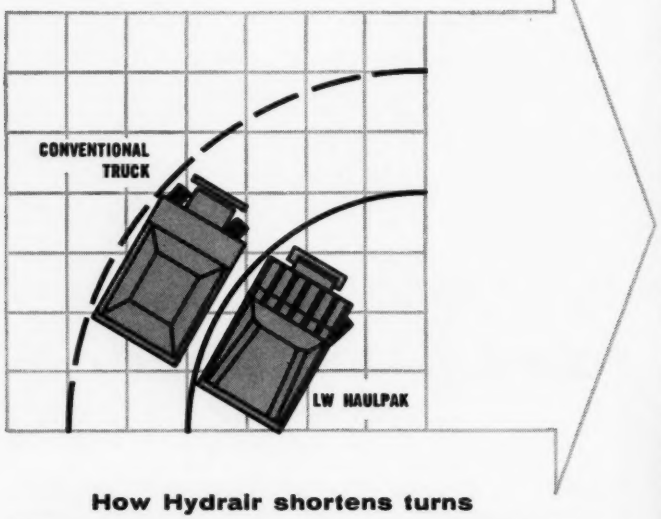
LW HAULPAK®

turns short . . .

The time-saving maneuverability you get from Haulpak's power-steer system, from Hydrair® suspension, and from its short wheelbase can add extra trips to your daily production. LeTourneau-Westinghouse Haulpak trucks make continuous 180° turns in confined quarters where other trucks have to jockey back-and-forth two and three times.

⅓ shorter turn circle

Haulpak turns in ⅓ *less* space than comparable haulers, and much shorter than many smaller rigs. This exceptional maneuverability lets you spot, swing around, back up, and dump without lost motion, or unnecessary delays in haul cycles.



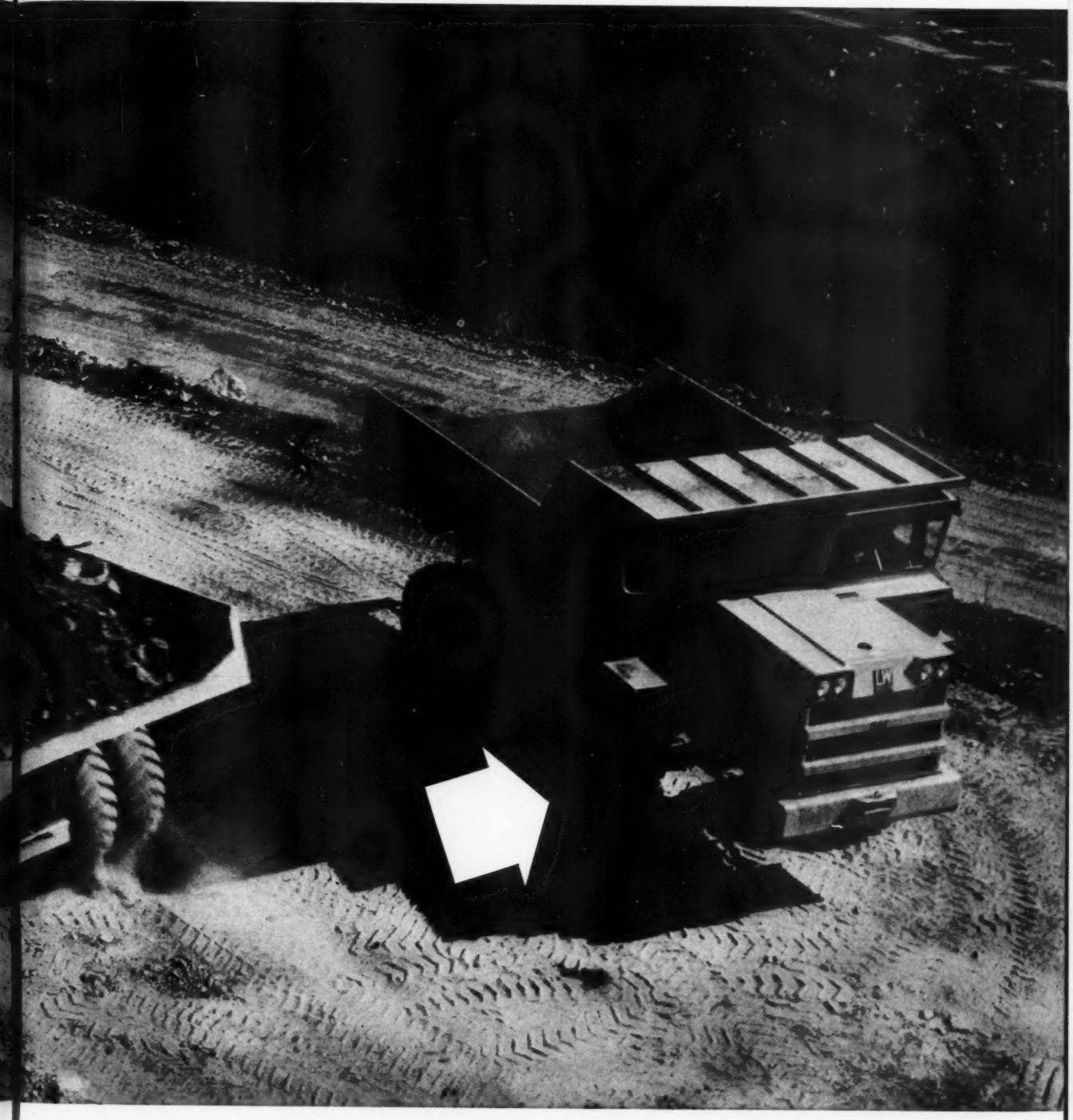
How Hydrair shortens turns

With exclusive LW Hydrair suspension, conventional front-axle and springs are eliminated. There's no interference with steering wheels. You get a sharp 45° front-wheel turn in each direction. In addition, the elimination of big, long springs, front and rear, shortens Haulpak wheelbase . . . further reducing turn radius. There is, however, no sacrifice in load capacity because of LW's deep V-body design.

There are many other ways Haulpak saves time and money. Your LeTourneau-Westinghouse Distributor will be happy to tell you about them, and will arrange to show you these off-road trucks in action. 5 end-dump sizes, 22 to 65 tons . . . up to 600 hp. 90-ton bottom-dump also available.

HP-2467-G-2

. . spots fast



LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

This mark tells you a product is made of modern, dependable Steel.

TIGER ON THE SPOT AT PEABODY COAL COMPANY

USS Tiger Brand drag ropes average 750 hours in rugged service

This 32-cubic-yard dragline operates around the clock digging overburden at Peabody's Airline Mine, near Linton, Indiana. It is rigged with a pair of 2⅝" USS Tiger Brand drag ropes 275 feet long. These are subject to severe abrasion and heavy shock loads . . . but they last from 700 to 800 hours.

The Tiger Brand hoist ropes last up to 1800 hours. These are 2⅛" in diameter and 477 feet long, designed to meet the specific requirements of this service.

Whatever the equipment—whatever the purpose—you'll find USS Tiger Brand Wire Rope designed to meet your most exacting requirements. It's a top-quality product. Specified standards are maintained for every step of production. Plant facilities are unsurpassed in the industry. These facilities, along with one of the finest staffs of wire rope engineers in the country, assure wire rope with complete dependability, long service life and maximum economy.

Put the Tiger on the spot! Where you have a large variety of wire rope applications, the Tiger Brand Field Service Representative can be of great help. Call him in to make a check of your equipment. The chances are he can save you money. His services can be obtained through your local Tiger Brand distributor or by writing direct to American Steel and Wire, Dept. 1462, Rockefeller Building, Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks

American Steel and Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
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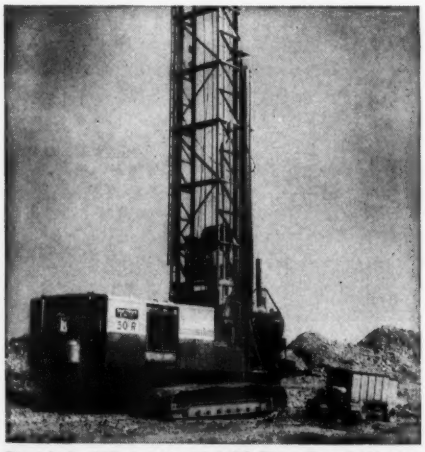
United States Steel Export Company, Distributors Abroad

USS Tiger Brand 2⅛" diameter drag rope provides a good balance of resistance to abrasion and bending fatigue.



Blast hole drill rigged with USS Tiger Brand ⅞" hoist line and ⅞" pull-down line for maximum service.

RAY-MAN CONVEYOR BELTS On Giant Wheel Excavators

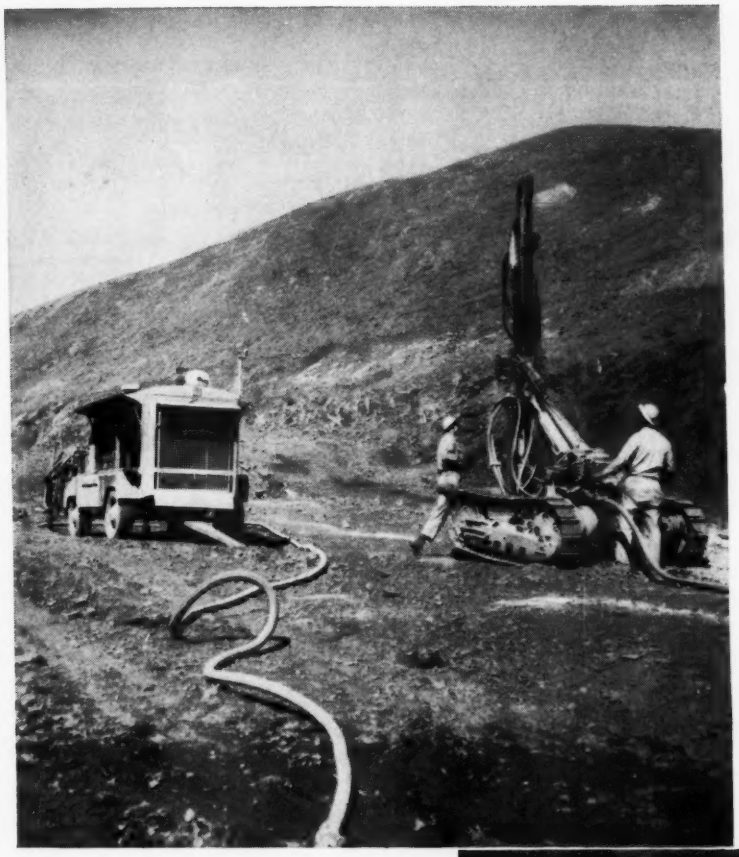
Move Overburden More Than 400 Feet ...At 5100 Tons Per Hour!

High-speed belt conveyors, with huge carrying capacities, are an integral part of this new 1,600 ton wheel excavator built for Peabody Coal Company at Bucyrus-Erie Company. High conveyor speeds—over 1,000 FPM—and high impact, put a tremendous strain on belt and belt splice. Ordinary belts can't take it. Ray-Man Conveyor Belting met the production standards of Peabody's giant earthmover—to handle *full* loads of overburden at *full* speeds *without* costly downtime for splice repairs!

Ray-Man belts on other machines of this type have hauled over 12,000,000 tons—outperforming all competitive belts. Splices last twice as long because double ply compensation relieves outer ply stress at bends. Ray-Man trains naturally, resists impact and ripping, requires no breaker ply. Exclusive XDC cover prolongs belt life. Let an R/M distributor show you how an R/M Conveyor Belt can outperform other belts on *your* conveyors. Write for Bulletin M302 and Catalog 25CB.

OVER 900 FT. OF 54" RAY-MAN CONVEYOR BELT are required for digging ladder and stacker conveyors on this huge Bucyrus-Erie Wheel Excavator. Machine will help increase output a million tons annually at Peabody Coal Company's River King Mine near Freeburg, Illinois.

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS



HOMOFLEX HOSE Weighs Less Than Any Other Hose For Equal Pressure

It's flexible as a rope, too . . . the easiest handling air hose you can use. Homoflex has no pre-set twist . . . coils and uncoils in *any* direction *without* kinking. Strength member and tube are virtually inseparable. Uniform inside and outside diameters make it easier, *safer* to couple.

- **Super-Strong** — assures longer, trouble-free service life
- **Precision Built** — with super-strength, low-stretch cords
- **Mandrel-Made**—no pre-set twist
- **Kinkless**—coils and uncoils freely in any direction
- **Homogeneous Construction**—provides inseparable tube-to-cover bond
- **Safer, Easier To Couple**—inside and outside diameters are uniform

Ask about rugged Homoflex and other types of R/M hose for your applications. Write for Bulletins M620 and M694.

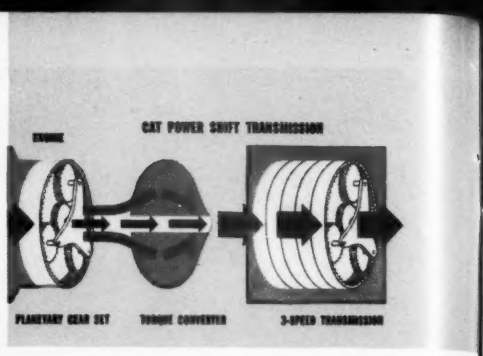
CONDOR Flexible Rubber Pipe Outlasts Iron or Steel 3 to 10 Times

It's engineered for mine service . . . for handling tailings, cinders, slag or flotation feed . . . on dewatering lines—wherever pipelines are subject to corrosion, abrasion, vibration or water hammer. Types to withstand pressures up to 250 psi feature new Hydro-Lok built-on flanges for positive seal.

R/M Rubber Expansion Joints—overcome pipe expansion stress and avoid misalignment, offer maximum resistance to shock, require no gaskets. Write for Bulletin 7152.

This Condor Rubber Pipe is still in service after 9 years. Previously steel pipe had to be replaced every year.

RM113



The exclusive Cat power shift transmission works like this: The engine drives planetary gears in the flywheel, where output torque is divided. Part of it is routed to the transmission through a torque converter (providing anti-stall and load-matching ability). Part goes direct to the three-speed transmission (provides economy and fast response of direct drive). It's one ton of muscle built with the precision of a fine watch.

WITH CAT POWER SHIFT TRANSMISSION IN A D8H, A MAN'S FINGER TIPS CAN CONTROL 30-50% MORE PRODUCTION

Your present equipment may move material at low cost—but here's one reason a D8 Series H Tractor may move it a lot cheaper.

It's the Caterpillar power shift transmission—the only transmission available that combines the advantages of direct drive, torque converter drive and power shifting in a single unit. It greatly increases operator efficiency—offers important new opportunities for broadening your profit margin.

Here's how this big step ahead in transmission design helps your operator get more work from the machine: A single selector lever replaces the familiar master clutch, gear change and forward-reverse levers. Using this single selector lever, the operator can shift on the go in a split-second even under full load. He changes speed or reverses direction with finger-tip ease . . . without clutching . . . without braking . . . without even lifting his arm from the arm rest. And the lever is mounted for left-hand control, leaving the right hand free for maneuvering the tractor or controlling the dozer, ripper or scraper. Convenience makes it easy to choose the right speed at the right moment.

Matching this ease of control are safety features you'll like. A safety lock in the selector housing holds a parked machine in neutral while the engine is running. Another safety device automatically shifts the selector lever to neutral when the engine is stopped.

The simplicity and safety of the Cat power shift transmission make your good operators even better and less experienced operators more effective. They can take greater advantage of the tractor's power and capacity to speed the work. And ease of operation keeps their efficiency high throughout the day.

Cat power shift transmission also means a big jump in your machine's efficiency too. You'll particularly notice the difference on jobs where frequent shifting is the rule—such applications as feeding a shovel or short-cycle dozing.

For instance, in dozing, the operator starts to pick up the load in second gear—then shifts on the go to first for full lug yardage. There's no clutching, no lost time or momentum when changing speeds. An easy move back to second drifts the material to its destination. Another move of the lever puts the machine in high-speed reverse for fast return to the digging area.

Machine efficiency is *always* high. Cat power shift transmission provides the needed power at the highest possible speed. Its exclusive torque divider design combines the snap and economy of direct drive with the load-matching ability and anti-stall characteristics of torque converter drive—and three forward-reverse speeds tailor it to the entire working range.

Just how much of an increase will the Cat power shift transmission make on your job? This will depend on your application. On short-cycle dozing, reports in our file show increases *as high as 50%* over similar-sized machines with other transmissions. Some users flatly state they will never buy another track-type machine in the 200 HP class unless it is a Cat power shift unit.

Power shift transmission is just one reason the D8H may be a far better profit tool than the machine you are now using. There are other features of this 235 HP turbocharged tractor that could be equally advantageous in your work. Your Caterpillar Dealer will welcome the opportunity to discuss the D8H in terms of your job and present facts and figures so you can determine true benefits. And if a demonstration with measured results would help, he will be glad to make arrangements.

Call him today.

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U.S.A.

CATERPILLAR

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STEP UP PRODUCTION AND PROFITS WITH POWER SHIFT TRANSMISSION

Editorial
MINING CONGRESS JOURNAL
ROBERT W. VAN EVERA, Editor
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Chain Reaction to Progress

In this age of complex technology, significant advances are gained through teamwork involving the efforts of many people in surprisingly varied positions in industry. Even the trade press comes in for a measure of credit for its contributions to industrial progress.

Thus, early this year, *Mining Congress Journal* became interested in what could well become a far-reaching development in rock-breaking. This led to a study now being made to determine the breaking effect of high-frequency electric energy applied to oversize rock fragments. An enthusiastic electrical manufacturer describes this development as one which "can make secondary blasting and explosive-breaking as much as 25 times more economical for the mining industry."

Briefly, the events leading up to this advanced research project are these. Late in 1960, articles describing research projects conducted by scientists behind the Iron Curtain were called to MJC's attention by an engineer of the U. S. Bureau of Mines whose job it was to review foreign technical literature.

While the language barrier posed a sizable problem for the *Journal,* its editors were convinced that this and other obstacles could be overcome, and that a limited program of republishing articles from overseas sources would be of value to our readers. (See editorial, "Brain Picking," *Mining Congress Journal,* March 1961.) This program was not conceived out of any special veneration for methods used abroad; rather, we felt that no one has a monopoly on good basic ideas, and often the unorthodox approach (in this case, unorthodox by American standards) tends to unfetter man's creative abilities.

The *Journal* accordingly arranged for translation of certain outstanding papers by Russian engineers, and has thus far published four of these articles. They have appeared in our March, May, July and September issues—with a fifth scheduled for December. These have been well received, with numerous expressions of interest by our readers.

One of these articles, "Dustless Breaking of Rocks Electrically," published in May, sparked almost immediate action. Within a month after receiving that issue, the Mining Research Department of The Anaconda Company at Butte initiated a research project at the Montana School of Mines "to determine if this method can be applied to low-grade copper and iron ores"—the company's grant to that School being based on our published article.

The method consists of impressing high-frequency, high-voltage electric current through two electrodes clamped on the rock to create a conductive path between them. This decreases the internal resistivity, making it possible to transmit high-energy power through the rock—thus building up thermal stresses along the conductive channel sufficient to crumble the material by differential expansion. The water of crystallization in the minerals apparently helps materially in the formation of the conductive channel. The method, it is believed, can be adapted to rocks of a wide variety of compositions and structures.

The first phase of the Montana School of Mines project has been completed. Richard M. Stewart, Anaconda's Director of Mining Research, describes the results as "encouraging," though he points out that the studies to date have been confined to secondary breakage, and to material in sizes of about a cubic foot. The company has under consideration the purchase of equipment designed to break rocks up to a cubic yard.

"Electrothermal forcing," as one of the manufacturers has termed the technique, will obviously yield greater savings if it can be applied to even larger rocks—a field still to be explored. More research is also needed to determine the best frequencies to be used. Work so far has been largely in the radio-frequency range of 20–30 megacycles, but indications of good results have been obtained using microwave frequencies on the order of 2000 megacycles.

The project is still strictly in the realm of research —the most practical kind of research—and *Mining Congress Journal* is pleased to have played a part in its inception.

Effect of Continuous Mining Equipment on Cleaning Plant Performance

The efficiency of coal preparation plants, cleaning coal produced by continuous mining methods, can be increased if a comprehensive study is made of plant feed

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IT has been argued that mule haulage is still the most efficient means of haulage. Not too many years ago an operation research team proved that cable haulage was the most efficient mine haulage system. A president of a management organization has said that it is not the new methods that help, but the interest generated by the new that accounts for improvement. It has been said that if the same amount of attention were directed to regular off-track equipment, there would be no case for continuous miners. Whether good results are due to the equipment or the necessity to pay closer attention to the work, progress has a way of happening. However, there are some points that should be considered from the preparation angle when a change to continuous mining is contemplated. It pays to look ahead and consider as many factors as possible.

Consider two hypothetical operations producing coal for the manufacture of coke and by-products. One mine produces low volatile coal with a ¼-in. by 0 slack product equal to 30 percent of the total clean coal and the other mine produces high volatile coal with the slack equal to 40 percent of the total clean coal production. Mine rejects from both mines can vary widely, depending on the particular areas being worked, with a range from five percent rejects to occasionally as high as 40–70 percent. Only one continuous miner is used at each operation. The problem of cleaning coal from conventional equipment in areas that have both hard and soft partings is as difficult as the preparation of coal from continuous miners in a clean seam of coal, because of the heavy blasting necessary to reduce hard partings to loadable condition.

In a review of the literature it was noted that some writers actually reported fewer fines with continuous miners, others reported anywhere from small increases to as much as 39 percent more ⅜ in. by 0. It should be considered that some operators who reported no increase may have been using dry sieve analyses, a faulty procedure if preparation is to be by wet methods. In cases where hard shooting is practiced because of binders in the seam, deep cutting or any other reason, there may be an increase in fines.

Size Down, Costs Up

It may be a good idea at this time to look at the relative capital costs of preparing coal of decreasing sizes:

On this basis it can be seen that the cost of a one percent shift in the amount slack is about $4000 per ton hour—a total cost of $18.00 per 450-tph capacity plant. The total cost of a one percent increase in the gross plant feed in minus 325-mesh dirt is $133,333 per ton hour or $600,000 for 450 tph. Some wet type dust collectors will require 300 hp per unit. If dust is doubled, two units may be required, so that in addition to substantial capital costs, the equivalent of another man per shift operating time is added to the payroll in power cost. The foregoing costs are good for initial thinking on a project, but each has differences that might greatly change any of the components.

Continuous mining is increasing because it eliminates wasted motion and combines several operations into one. It is unfortunate that much of the coal most suitable to continuous mining is gone. It has been pointed out in previous papers that continuous miners are best suited to areas of uniform conditions, preferably with no partings. Under these conditions it is probable that the prepar-

Table I
Comparative capital costs of cleaning various sizes based on 450 tph clean coal with 40 percent slack

Size of Coal	*Operation*	*Cost Pth of Cap.*	*TPH*	*Total*
1. + ⅜ in.	Crush, wash, size and load	$1,500	270	$ 405,000
2. ⅜ in. by 0	Wash, Mech. drying	2,500	180	450,000
3. ⅜ in. by 0	Heat dry	3,000	180	540,000
4. 325m × 0 refuse	Produce and dewater	133,333*	4.5	600,000
Total			450	$1,995,000

* *Per tph-325 mesh refuse.*

Raw feed to slack plant

Size	A. Cont. Miner		B. Off-Track Loader		C. Off-Track Loader	
	% Wgt.	% Ash	% Wgt.	% Ash	% Wgt.	% Ash
+ 3/8 rd.	15.4	13.3	9.6	17.2	9.5	27.7
3/8 x 1/4 rd.	19.8	7.6	17.9	9.0	15.5	18.8
1/4 x 8 m	25.7	6.8	24.8	9.0	23.9	19.3
8 x 16 m	12.9	6.8	17.0	8.6	17.2	21.1
16 x 30	8.9	7.1	10.6	7.6	10.8	17.9
30 x 50	6.4	7.6	7.7	7.5	8.4	18.0
50 x 100	3.5	8.7	4.9	7.2	5.0	17.0
100 x 0	7.4	13.6	7.5	14.1	9.7	26.8
Total	100.0	8.6	100.0	9.7	100.0	20.6

A. Continuous miner in relatively clean coal, B. Off-track loader in area similar to A, C. Off-track loader in area of high impurities.

Table II

Sieve analyses continuous mined-slack coal from low impurity area high volatile coal

High volatile coal

Size	Cont. Mined Coal*		Reg. Mined Coal**	
	% Wgt.	% Ash	% Wgt.	% Ash
+ 3/8 x 1/4	20.8	18.3	20.9	16.2
1/4 x 8 m	35.9	14.4	32.1	13.8
8 x 16	15.0	15.7	17.3	14.9
16 x 30	10.6	16.9	9.2	14.3
30 x 50	7.9	18.7	7.4	15.7
50 x 100	4.5	19.6	4.4	17.3
100 x 0	5.3	19.6	8.5	19.8
	100.0	17.3	100.0	15.3

** Dry Sieve Analysis.*
*** Wet Sieve Analysis.*

Table III

Sieve analysis continuous mined slack coal from high impurity area compared to regular mining in same area

Size	Cont. Miner		Regular Mining		– 1.30 Sp. Gr. Mat.	
	– 1.40 Sp. Gr. % Ash	– 1.70 Sp. Gr. % Ash	– 1.40 Sp. Gr. % Ash	– 1.70 Sp. Gr. % Ash	Cont. Miner % Ash	Regular Mining % Ash
+ 3" rd.	4.31	11.79	6.40	10.06	2.92	2.35
3 x 1 1/2 rd.	3.95	6.63	3.07	8.75	3.00	2.56
1 1/2 x 3/4 rd.	4.19	6.44	3.85	6.17	2.97	2.83
3/4 x 3/8 rd.	3.94	5.93	3.82	5.50	2.94	2.74
3/8 x 1/4 rd.	3.86	5.68	3.62	4.92	2.88	2.30
1/4 x 8 m	3.47	5.39	3.28	4.54	2.86	2.14
8 m x 16 m	3.32	5.27	2.87	4.28	2.22	1.86
16 m x 30 m	3.00	5.87	2.64	4.05	2.24	1.64
30 m x 50 m	3.82	6.28	2.32	3.78	2.64	1.43
50 m x 100 m	4.26	6.67	2.06	3.28	2.81	1.33
Composite	3.86	6.31	3.54	5.99	2.83	2.47
Comp. + 3/8	4.05	6.82	3.74	6.92	2.97	2.70
Comp. – 3/8	3.60	5.62	3.25	4.58	2.65	2.15

ation problem is not seriously affected except for possible screening difficulties due to wetting of dust at the face. If the seam contains hard partings of any number or size, continuous mining is ruled out because of a slow cutting rate and low production. It is the borderline cases that have to be considered more carefully, that is, where the seam contains bands of impurities of small size or of intermediate or less hardness. In fact, it will be noted in studying some data that the screen analyses favoring continuous miners are made with dry sieve analyses which are misleading as subsequent wet sieve analyses prove.

Feeds Compared

Table II shows comparative wet sieve analyses of raw slack feed to tables of coal from a continuous miner compared to conventional mining in the same area under similar conditions and also

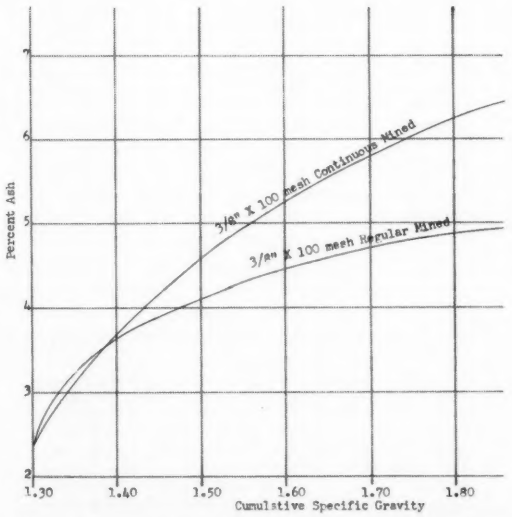


Fig. 1. Low volatile coal, ash vs specific gravity—continuous mining compared with conventional mining

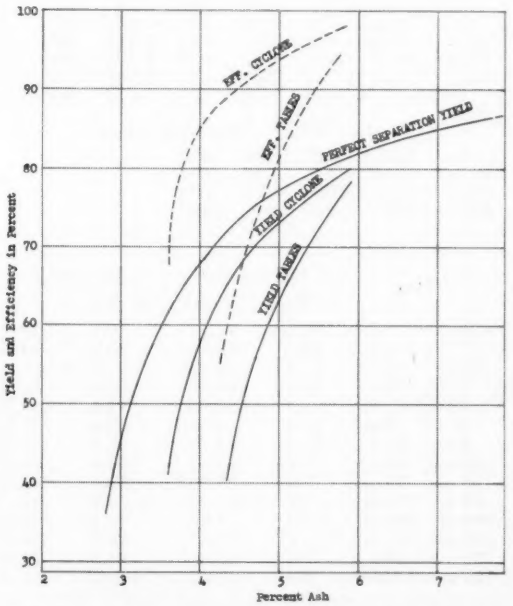


Fig. 2. Low volatile coal, yield and efficiency vs ash for cyclones and wet tables 1/4 in. by 8 mesh sizes mined by continuous mining equipment

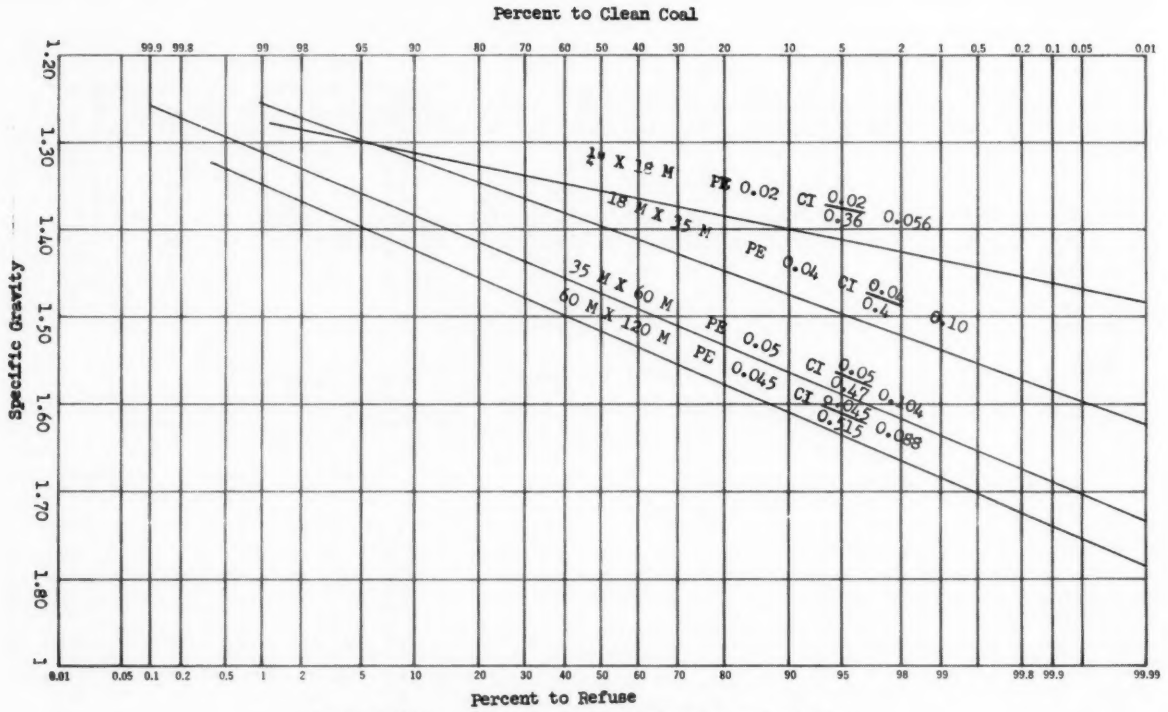


Fig. 3. Probability plot, cyclone washer distribution to coal and refuse

I. Data for Tables

Size	10 Tables Group I: Separation Sp. Gr.	Probable Error	Coef. of Imperfection	10 Tables Group II: Separation Sp. Gr.	Probable Error	Coef. of Imperfection
+ 3/8 rd.	1.471	.072	.153	1.594	.100	.169
3/8 x 1/4 rd.	1.537	.082	.154	1.631	.071	.112
1/4 x 8 m	1.518	.102	.193	1.627	.074	.118
8 m x 16 m	1.528	.102	.193	1.550	.061	.111
16 m x 30 m	1.630	.145	.230	1.570	.093	.167
30 m x 50 m	1.692	.140	.203	1.740	.162	.219
Average	1.560	.103	.184	1.632	.099	.158

II. Data for Washing Cyclone

1/4 x 18 m	1.360	.020	.056
18 m x 35 m	1.395	.040	.100
35 m x 60 m	1.470	.050	.104
60 m x 120 m	1.515	.045	.088

Size	Elementary % Wgt.	Elementary % Ash	Accumulative % Wgt.	Accumulative % Ash
+ 3"	9.6	71.17	9.6	71.17
3" x 1½"	10.9	58.66	20.5	64.52
1½" x ¾"	11.4	45.52	31.9	57.73
¾" x ⅜"	12.1	33.00	44.0	50.93
⅜" x ¼"	8.4	23.62	52.4	46.55
¼" x 8 m	11.0	17.66	63.4	41.54
8 m x 16 m	11.5	14.24	74.9	37.35
16 m x 30 m	8.9	13.42	83.8	34.81
30 m x 50 m	5.8	13.10	89.6	33.40
50 m x 100 m	3.9	17.03	93.5	32.72
100 m x 200 m	1.9	14.69	95.4	32.36
200 m x 325 m	1.2	13.87	96.6	32.13
325 m x 0 Dry	0.4	15.96	97.0	32.06
325 m x 0 Wet	3.0	28.26	100.0	31.95

Table VI
R.O.M. continuous mined coal—low volatile seam screen analysis – 3 by 0 sizes = 100 percent of total

Table V
Coefficient of imperfection for tables and cyclones versus size and specific gravity of separation

compared to conventional mining from an area having high impurities.

It will be noted in this analysis that analyses in like areas are practically the same, with the continuous miner in this instance producing slightly coarser coal than the conventional equipment. The off-track

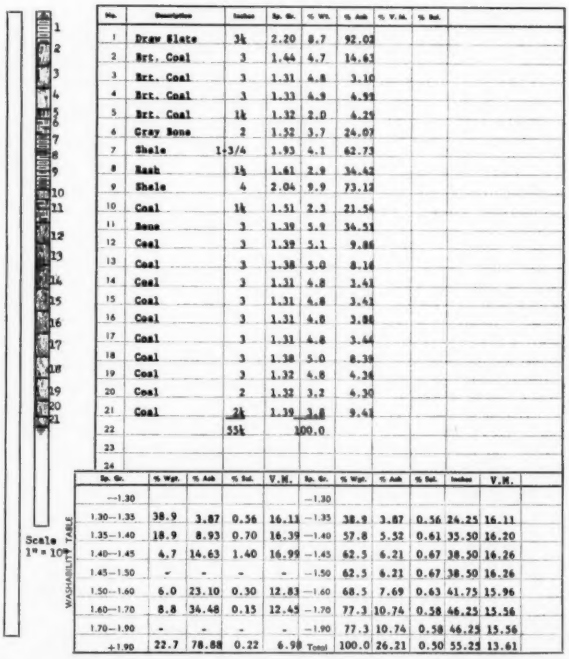


Fig. 4. Low volatile coal—columnar section analysis. This data is useful in plotting iso-ash and iso-reject maps

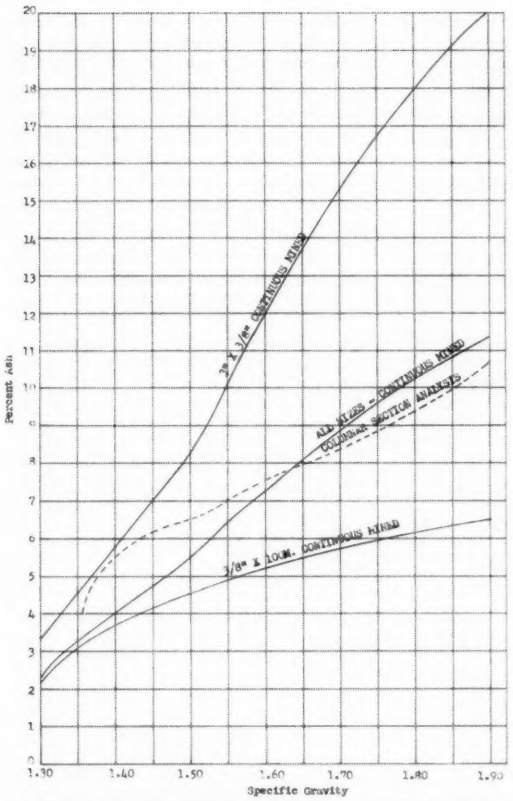


Fig. 5. Low volatile coal, cumulative ash vs specific gravity for 3 by ⅜ in. and ⅜ in. by 100 M sizes compared to total and columnar section analyses

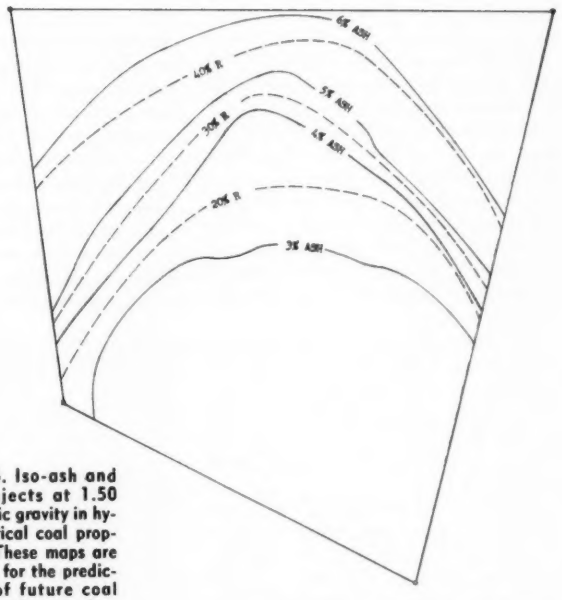


Fig. 6. Iso-ash and iso-rejects at 1.50 specific gravity in hypothetical coal property. These maps are useful for the prediction of future coal preparation requirements

loader in a high impurity area produces more 100-m by 0. It is interesting to note, however, that the 100-m by 0 material in each case would calculate to be about 6.5 percent coal of five percent ash with the difference shown in the analyses being due to impurities as shown by the ash. Table III shows the effect on plant feed of slack mined by a continuous miner and conventional equipment in an area of high impurities. These analyses are practically the same when allowance is made for dry sieve analysis on the continuous mined coal, which always makes several percent difference in the 100-m by 0 sizes on high ash slack.

Coal preparation is almost wholly affected by the size and specific gravity consist of the plant feed so that these are the main variables to consider when studying the effects of different types of mining on the preparation plant. In table IV it will be noted that continuous miner ash is high in the plus ⅜-in. and minus ⅜-in. sizes of the 1.30 and 1.40 specific gravity float fractions. At 1.70 specific gravity, the plus ⅜-in. fraction is substantially higher in ash content. The most noticeable difference shown by this table is the tendency for the float fractions to increase in ash below 16-m as the size diminishes so that the difference in the 50 by 100-m, 1.30 specific gravity float fraction, for example, is 2.82 percent ash for continuous mining versus 1.33 percent ash for regular mining.

To consider the effect of continuous miners on the whole size range, refer to chart I showing the comparison of the sizing of the minus 1.50-specific gravity float fractions of continuous and regular mined low volatile coal. Actually, these analyses are from two different parts of the seam, the regular conventionally mined coal being from the better part at an earlier time when less

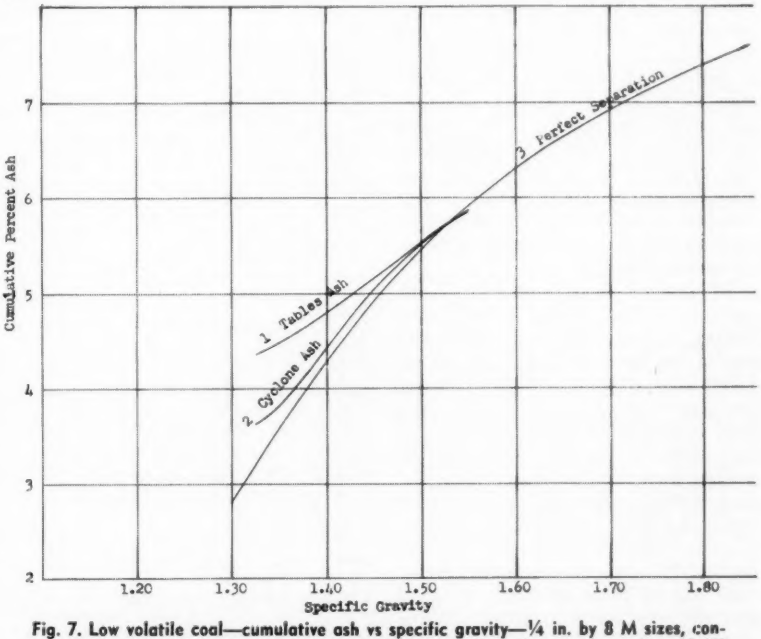


Fig. 7. Low volatile coal—cumulative ash vs specific gravity—¼ in. by 8 M sizes, continuously mined, (1) projected table ash, (2) projected cyclone washer ash, and (3) perfect separation

emphasis was placed on loading speed. Subsequent analyses showed little difference and the need for high speed loading and well-shot coal has eliminated much of the difference that may have existed between the site analyses of continuous and regular mined coal. However, this comparison is presented to show that there is a possibility of getting more fines with continuous mining, particularly if present mining is careful because of the lack of complete cleaning facilities.

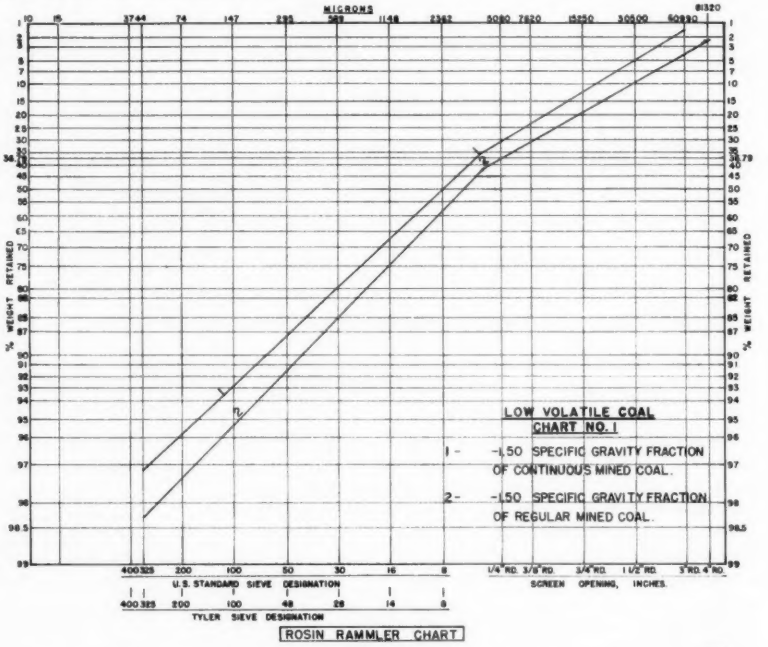
Chart No. 2 shows the comparison between raw feeds of continuous and carefully mined regular coal. And again there is not much difference between continuous mined coal and regular mined coal from high speed loading.

Chart No. 3 illustrates the same continuous mined coal and compares the minus 1.30, minus 1.50 and raw coal size analyses. A study of this chart will reveal that the small sizes tend to increase in boney material and for some reason, not much minus 100-m is produced in the minus 1.30 specific gravity float fraction.

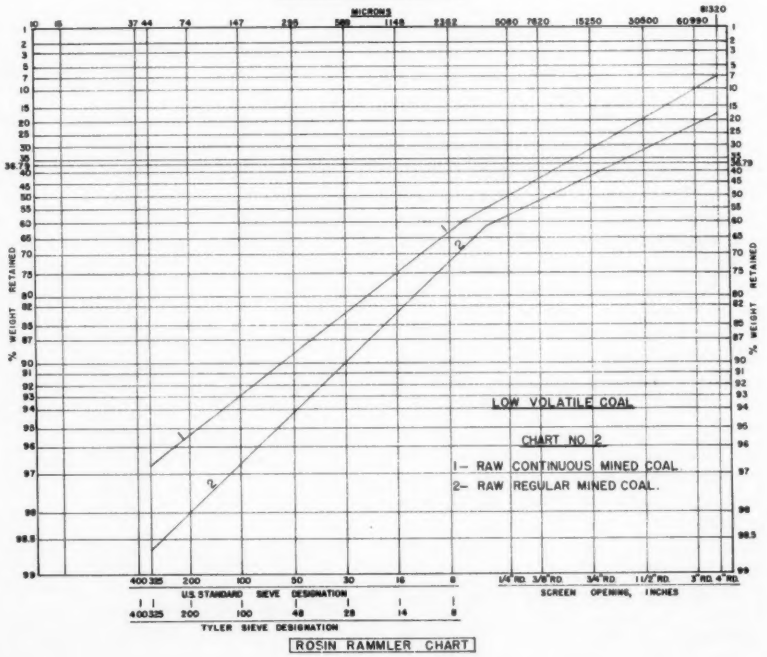
The tendency for a decrease in the minus 50-m sizes indicates that the minus 1.30 specific gravity fraction of this coal is more brittle than the midcoal. In addition to plotting the results on Rosin-Rammler coordinates, the analyses were rerun to check this suspected anomaly. This increase in boney material in the extreme fines blackens the froth plant tailings if the equipment is designed for recovery of lower ash material. The Rosin-Rammler plot is useful to check the accuracy of results as well as to indicate whether any sizes are missing. The results here indicate that no appreciable loss of fines had occurred. It may also be used to check whether degradation is uniform or has occurred only in smaller sizes resulting from water recycling.

In figure 1, low volatile coal, ash versus specific gravity continuous mining is compared to regular mining in the same area for the $\frac{3}{8}$ by 100-m size. Here, the effect of greater concentration of bone in the small sizes is also noted. It should be noted that the ash in the 1.90 specific gravity float fraction is over $1\frac{1}{2}$ percent higher in the continuous mined coal. The float 1.60 specific gravity fraction ash is over 0.8 percent higher. The importance of this difference will be noted in figure 2, yield and efficiency versus ash for cyclone and wet tables on continuous mined $\frac{1}{4}$ by 8-m size, low volatile coal. The $\frac{1}{4}$ by 8-m size was used because the characteristics are approximately average for the total slack. In practice, it would be wise to add at least one percent to the ash abscissa to account for the portion of the 100-m by 0 size that will be entrapped in the product unless provisions are made to froth or waste all of this material. The latter alternative is costly but is sometimes practiced. If the fine material is entrapped the ash will be increased from five to six percent. It will be noted that the theoretical efficiency of tables is 82 percent versus 94 percent on a cyclone washer. On a 1,000,000 ton year of five percent ash slack fed to a plant, the cyclones will recover 940,000 tons which will cost $94,000 extra for magnetite for the tables will produce only 820.000 tons and the plant will lose $5.00 per ton or $600,000.

Figure 3 and table V were used in calculating the yield curves. The data on tables taken from our own


MICRONS
% WEIGHT RETAINED
LOW VOLATILE COAL
CHART NO. 1
1 - -1.50 SPECIFIC GRAVITY FRACTION OF CONTINUOUS MINED COAL.
2- -1.50 SPECIFIC GRAVITY FRACTION OF REGULAR MINED COAL.
U.S. STANDARD SIEVE DESIGNATION
TYLER SIEVE DESIGNATION
SCREEN OPENING, INCHES.

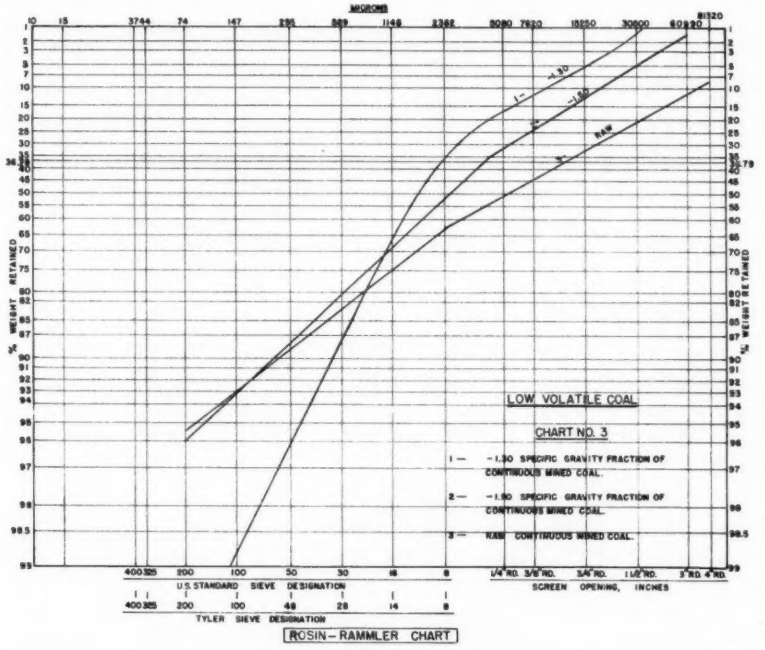
ROSIN RAMMLER CHART

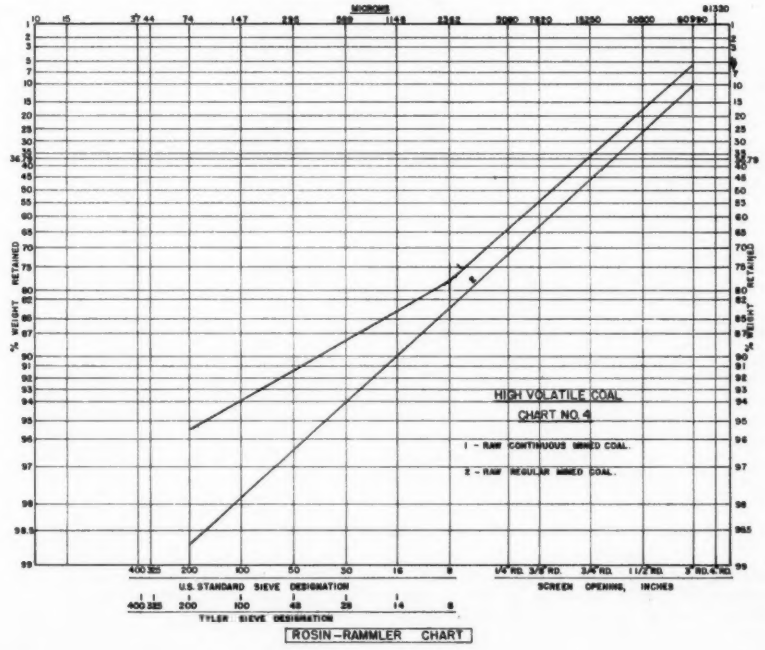


ROSIN RAMMLER CHART

tests agrees with published data and the data on cyclones were derived from manufacturers' data. It may be that actual plants will perform better than indicated by laboratory tests. It can be seen, however, that if bone is concentrated in the fine sizes it may be necessary to consider the cyclone washer and complete clarification of all slack plant water before recycling.

Figure 4, columnar section analyses, shows an analysis of the coal at the face in an area being worked by a continuous miner. The cumulative ash results of the washability table of the columnar section analyses are plotted on figure 5 along with the continuous miner total plant feed, coarse coal feed and slack feed. This graph shows the difficulty in using columnar section samples to predict preparation plant results unless it is planned to ship one product, in which case the results are usually conservative. Actual results from test runs of equipment being considered are necessary. Columnar section analyses are useful in plotting iso-ash maps and iso-reject maps of a property as shown in figure 6. This data is useful in estimating future difficulties and would prevent installation of inefficient equipment that subsequently has to be replaced at great cost. In addition to test runs on equipment being considered, it is advisable to investigate the characteristics of the future coal.


MICRONS
% WEIGHT RETAINED
LOW VOLATILE COAL
CHART NO. 3
1 — -1.30 SPECIFIC GRAVITY FRACTION OF CONTINUOUS MINED COAL.
2 — -1.90 SPECIFIC GRAVITY FRACTION OF CONTINUOUS MINED COAL.
3 — RAW CONTINUOUS MINED COAL.
U.S. STANDARD SIEVE DESIGNATION
TYLER SIEVE DESIGNATION
SCREEN OPENING, INCHES
ROSIN-RAMMLER CHART



Water Clarification

Chart No. 2 shows the effect of continuous mining or high speed mining on the water clarification problem. It may be noted that the minus 325-m sizes increase from 1.4 to 3.4 percent of the total feed. If the increase is due to impurities it will be necessary to increase bleed to water clarification facilities or suffer an increase in ash in the slack due to entrapment. Another alternative is to use screen-type centrifuges and waste some fine coal either in the wet or dry stage. The dry stage wasting from heat dryers is frowned upon and results in additional wet scrubbing that increases the water clarification problem. The cost of an increase in water clarification facilities in one instance can be derived from table I.

One of the most serious costs of increased dust that is not often realized is wind and leakage losses. In a heat drying test on a low volatile coal where wet coal was shipped to a drying plant only 65 tons of the 900 tons shipped was water. Since losses occur in transit, in the drying process and in loading before the coal is weighed, the actual loss due to heat drying is difficult to determine. This loss may be lessened by extra use of oil which must be computed into the cost.

The increase in capital costs due to more slack sizes for heat drying and cleaning equipment may also be gleaned from table I. In this connection, limitation of production of present equipment might also be an added cost depending on circumstances. If continuous mining increases the slack, the added cost of heat drying for each one percent increase will range around 0.5 cents per ton of plant product neglecting dust losses previously discussed.

Summary

In summary it may be seen, that it is hard to determine the effect of continuous mining on coal prepara-

tion since it will depend on the system of mining. Users of air or gas type blasting procedures practicing careful face preparation may be in for a change. Others will need to study their own situation with actual test runs. To study the effect of continuous mining on coal preparation means to study its effect on the size and specific gravity fractionation of the plant feed. The greatest cost may be incurred meeting specifications for ash in the slack sizes. A tentative study outline might be as follows:

1. **Complete size and gravity fractionation of section being tested while running present equipment.**
2. **Complete size and gravity fractionation of section being tested while running proposed continuous mining equipment.**
3. **Comparison of sizing analyses to evaluate effect on fine coal and water clarification capacity.**
4. **Plotting of projected washer results from distribution functions to compare efficiency at various ash contents that may be desired now or in the future.**
5. **Columnar section analyses of area should be compared with reserves with iso-ash, iso-reject and probably more to point would be iso-midcoal map.**

Consideration of these points will give an accurate projection of whether continuous mining will affect preparation costs or quality adversely and indicate whether the preparation equipment will have to be added to or replaced.

Size	Elementary % Wgt. of Size	Elementary % Wgt. of Total	Elementary % Ash	Accumulative % Wgt. of Size	Accumulative % Wgt. of Total	Accumulative % Ash
⅜" × ¼"	15.0	8.4	23.62	15.0	8.4	23.62
¼" × 8 m	19.6	11.0	17.66	34.6	19.4	20.24
8 m × 16 m	20.5	11.5	14.24	55.1	30.9	18.01
16 m × 30 m	15.9	8.9	13.42	71.0	39.8	16.98
30 m × 50 m	10.4	5.8	13.10	81.4	45.6	16.49
50 m × 100 m	7.0	3.9	14.73	88.4	49.5	16.35
100 m × 200 m	3.4	1.9	14.69	91.8	51.4	16.29
200 m × 325 m	2.1	1.2	13.87	93.9	52.6	16.23
325 × 0 Dry	0.7	0.4	15.96	94.6	53.0	16.23
325 × 0 Wet	5.4	3.0	28.26	100.0	56.0	16.87

Composite ⅜" × 100 m Sizes = 49.5% Total

Sp. Gr.	Elementary % Wgt. of Size	Elementary % Wgt. of Total	Elementary % Ash	Accumulative % Wgt. of Size	Accumulative % Wgt. of Total	Accumulative % Ash
– 1.30	36.8	18.21	2.26	36.8	18.21	2.26
1.30 – 1.35	24.3	12.01	4.28	61.1	30.22	3.06
1.35 – 1.40	10.2	5.03	7.12	71.3	35.25	3.64
1.40 – 1.50	8.6	4.26	12.86	79.9	39.51	4.64
1.50 – 1.60	3.4	1.69	21.62	83.3	41.20	5.33
1.60 – 1.70	2.1	1.05	29.66	85.4	42.25	5.94
1.70 – 1.90	2.2	1.08	39.48	87.6	43.33	6.77
+ 1.90	12.4	6.17	83.58	100.0	49.50	16.35

Composite + 3" × ⅜" Sizes = 44.0% Total

Sp. Gr.	Elementary % Wgt. of Size	Elementary % Wgt. of Total	Elementary % Ash	Accumulative % Wgt. of Size	Accumulative % Wgt. of Total	Accumulative % Ash
– 1.30	5.0	2.18	3.40	5.0	2.18	3.40
1.30 – 1.35	12.9	5.68	4.97	17.9	7.86	4.53
1.35 – 1.40	7.6	3.37	9.12	25.5	11.23	5.91
1.40 – 1.50	7.1	3.14	17.41	32.6	14.37	8.42
1.50 – 1.60	7.9	3.48	27.43	40.5	17.85	12.13
1.60 – 1.70	6.0	2.62	36.28	46.5	20.47	15.22
1.70 – 1.90	7.9	3.47	48.68	54.4	23.94	20.07
+ 1.90	45.6	20.06	87.76	100.0	44.00	50.93

Table VII

Run-of-mine continuous mined coal—low volatile seam
Screen analysis ⅜" × 0" sizes = 56.0 percent total

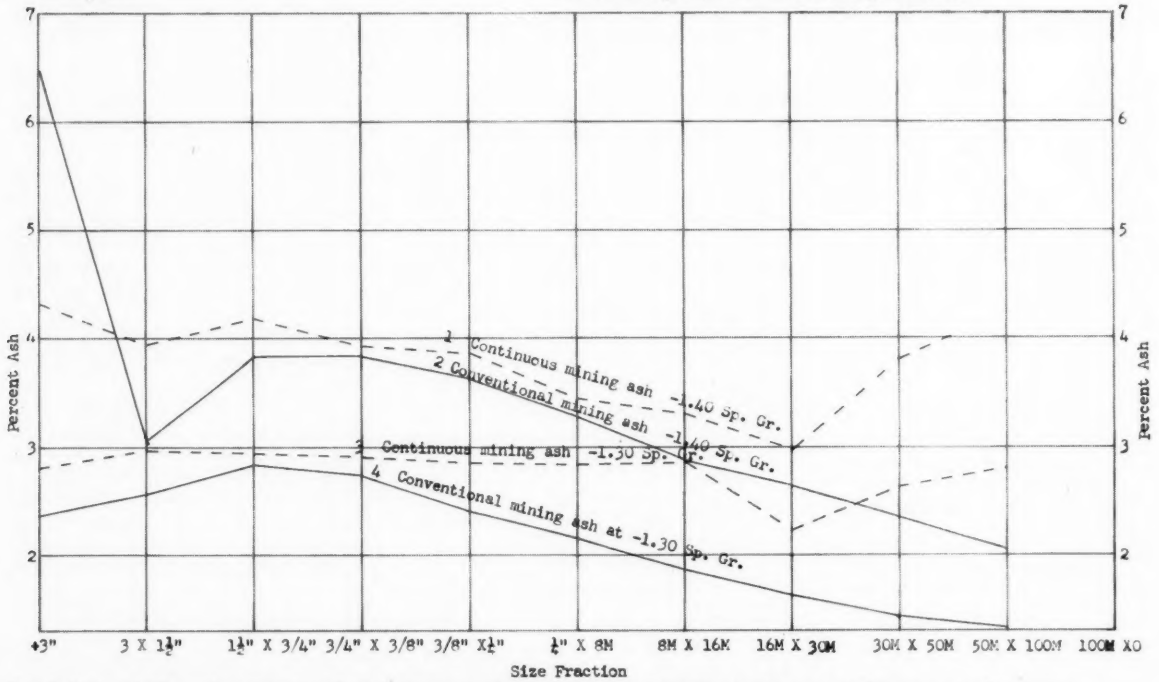


Fig. 8. High volatile coal—comparison float fractions, continuous mining vs conventional mining in similar areas: 1. Continuous mining – 1.40 Sp. Gr. ash vs size fraction; 2. Conventional mining – 1.40 Sp. Gr. ash vs size fraction; 3. Continuous mining – 1.30 Sp. Gr. ash vs size fraction; 4. Conventional mining – 1.30 Sp. Gr. ash vs size fraction
(Data from table III)

Table 8 — Composite + 3" x 100 m Sizes = 93.5% Total

Table 9 — + 3" Sizes = 9.6% Total

Table 10 — 3" x 1½" Sizes = 10.9% Total

Table 11 — 1½" x ¾" Sizes = 11.4% Total

Elementary

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	21.8	20.40	2.38	0.3	0.03	2.92	1.8	0.20	3.26	8.9	1.01	3.06
1.30 – 1.35	17.7	16.62	4.58	0.9	0.09	2.97	4.2	0.46	4.99	12.7	1.45	4.70
1.35 – 1.40	9.3	8.69	7.64	3.8	0.36	9.77	7.6	0.83	8.94	8.3	0.95	9.35
1.40 – 1.50	8.3	7.74	13.99	1.8	0.17	15.05	6.9	0.75	17.92	8.7	0.99	17.65
1.50 – 1.60	5.6	5.21	24.88	11.2	1.08	29.94	7.0	0.76	27.33	7.4	0.84	25.94
1.60 – 1.70	4.0	3.70	33.74	6.6	0.63	36.46	8.5	0.93	36.31	6.1	0.70	36.27
1.70 – 1.90	4.7	4.38	46.89	11.3	1.08	50.69	9.7	1.06	48.46	7.3	0.83	47.35
+ 1.90	28.6	26.76	85.94	64.1	6.16	92.01	54.3	5.91	86.24	40.6	4.63	85.57

Accumulative

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	21.8	20.40	2.38	0.3	0.03	2.92	1.8	0.20	3.26	8.9	1.01	3.06
1.30 – 1.35	39.5	37.02	3.37	1.2	0.12	2.96	6.0	0.66	4.47	21.6	2.46	4.03
1.35 – 1.40	48.8	45.71	4.18	5.0	0.48	8.07	13.6	1.49	6.96	29.9	3.41	5.51
1.40 – 1.50	57.1	53.45	5.60	6.8	0.65	9.89	20.5	2.24	10.63	38.6	4.40	8.24
1.50 – 1.60	62.7	58.66	7.31	18.0	1.73	22.41	27.5	3.00	14.86	46.0	5.24	11.08
1.60 – 1.70	66.7	62.36	8.88	24.6	2.36	26.16	36.0	3.93	19.94	52.1	5.94	14.05
1.70 – 1.90	71.4	66.74	11.38	35.9	3.44	33.86	45.7	4.99	25.99	59.4	6.77	18.13
+ 1.90	100.0	93.50	32.72	100.0	9.60	71.17	100.0	10.90	58.66	100.0	11.40	45.52

Table 12 — ¾" x ⅜" Sizes = 12.1% Total

Table 13 — ⅜" x ¼" Sizes = 8.4% Total

Table 14 — ¼" x 8 m Sizes = 11.0% Total

Table 15 — 8 m x 16 m Sizes = 11.5% Total

Elementary

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	7.8	0.94	3.81	16.0	1.35	2.43	36.5	4.02	2.82	52.2	6.00	2.18
1.30 – 1.35	30.4	3.68	5.12	37.4	3.14	4.43	26.1	2.87	4.74	19.1	2.20	4.96
1.35 – 1.40	10.2	1.23	8.88	9.7	0.81	8.69	9.1	1.00	8.77	7.4	0.85	8.81
1.40 – 1.50	10.2	1.23	17.22	8.2	0.69	15.69	8.2	0.90	15.49	6.1	0.70	15.28
1.50 – 1.60	6.6	0.80	25.72	4.3	0.36	25.08	3.4	0.37	26.89	2.3	0.26	25.16
1.60 – 1.70	3.0	0.36	35.88	2.6	0.22	35.41	1.8	0.20	38.00	1.3	0.15	35.64
1.70 – 1.90	4.1	0.50	47.00	3.1	0.26	47.86	1.8	0.20	47.15	1.2	0.14	46.52
+ 1.90	27.7	3.36	85.66	18.7	1.57	85.43	13.1	1.44	83.01	10.4	1.20	85.98

Accumulative

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	7.8	0.94	3.81	16.0	1.35	2.43	36.5	4.02	2.82	52.2	6.00	2.18
1.30 – 1.35	38.2	4.62	4.85	53.4	4.49	3.83	62.6	6.89	3.62	71.3	8.20	2.93
1.35 – 1.40	48.4	5.85	5.70	63.1	5.30	4.57	71.7	7.89	4.28	78.7	9.05	3.48
1.40 – 1.50	58.6	7.08	7.70	71.3	5.99	5.85	79.9	8.79	5.43	84.8	9.75	4.33
1.50 – 1.60	65.2	7.88	9.53	75.6	6.35	6.94	83.3	9.16	6.30	87.1	10.01	4.87
1.60 – 1.70	68.2	8.24	10.68	78.2	6.57	7.90	85.1	9.36	6.97	88.4	10.16	5.32
1.70 – 1.90	72.3	8.74	12.76	81.3	6.83	9.42	86.9	9.56	7.80	89.6	10.30	5.88
+ 1.90	100.0	12.10	33.00	100.0	8.40	23.62	100.0	11.00	17.66	100.0	11.50	14.24

Table 16 — 16 m x 30 m Sizes = 8.9% Total

Table 17 — 30 m x 50 m Sizes = 5.8% Total

Table 18 — 50 m x 100 m Sizes = 3.9% Total

Elementary

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	52.7	4.69	1.99	28.7	1.66	1.81	12.5	0.49	2.43
1.30 – 1.35	15.8	1.40	4.31	18.2	1.06	2.51	34.5	1.34	3.17
1.35 – 1.40	9.9	0.88	7.17	19.8	1.15	3.82	8.6	0.34	5.29
1.40 – 1.50	6.8	0.61	13.76	14.1	0.82	7.61	13.9	0.54	8.66
1.50 – 1.60	2.2	0.20	22.04	3.7	0.21	12.34	7.4	0.29	13.83
1.60 – 1.70	1.4	0.12	35.84	2.6	0.15	19.38	5.5	0.21	15.22
1.70 – 1.90	1.1	0.10	42.02	1.6	0.09	26.56	7.4	0.29	26.43
+ 1.90	10.1	0.90	84.91	11.3	0.66	78.46	10.2	0.40	76.61

Accumulative

Sp. Gr.	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash	% Wgt. of Size	% Wgt. of Total	% Ash
– 1.30	52.7	4.69	1.99	28.7	1.66	1.81	12.5	0.49	2.43
1.30 – 1.35	68.5	6.09	2.52	46.9	2.72	2.08	47.0	1.83	2.97
1.35 – 1.40	78.4	6.97	3.11	66.7	3.87	2.60	55.6	2.17	3.34
1.40 – 1.50	85.2	7.58	3.97	80.8	4.69	3.48	69.5	2.71	4.40
1.50 – 1.60	87.4	7.78	4.43	84.5	4.90	3.86	76.9	3.00	5.31
1.60 – 1.70	88.8	7.90	4.91	87.1	5.05	4.32	82.4	3.21	5.96
1.70 – 1.90	89.9	8.00	5.37	88.7	5.14	4.71	89.8	3.50	7.65
+ 1.90	100.0	8.90	13.42	100.0	5.80	13.10	100.0	3.90	14.73

Developments in Taconite Blasting at Erie

Ever-changing pit conditions and innovations in blasting materials point up the need for continued experimentation and study to achieve optimum blasting performance

By F. D. BICKEL
Consulting Engineer
Wilmington, Del.

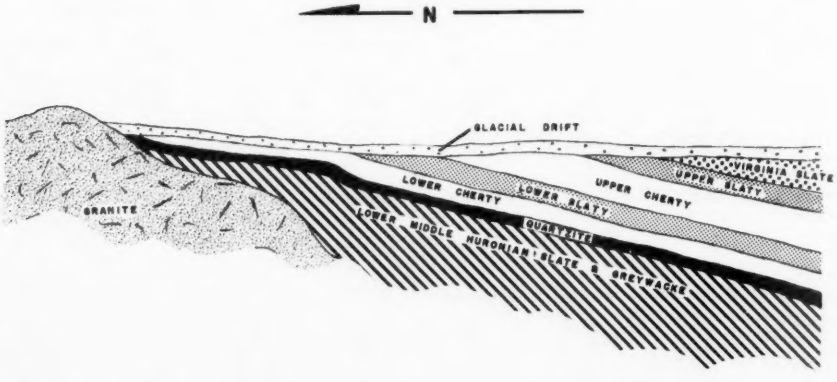
BLASTING in almost all types of open pit mines is one of the most important factors in the overall economy of the operation. Under the term blasting, the writer includes the preparation of primary blast holes as well as the actual loading and firing of a blast since the two are so closely related and interdependent. Consequently both must be properly designed and executed if the operator is to achieve optimum efficiency in the initial preparation of the raw material for handling and processing by his equipment.

In the author's opinion, one of the most challenging problems in this category today is the blasting of taconite on the Mesabi Range and specifically at the open pit operation of the Erie Mining Co. This organization is managed and directed by Pickands Mather & Co. of Cleveland.

Taconite containing a low percentage of magnetic iron ore is converted into a high grade product which is well adapted to and greatly in demand for blast furnace feed, in a process that was developed during an experimental program covering the period 1940 until 1957. In 1957 the first boatload of pelletized magnetite ore from Erie's Hoyt Lakes plant left Taconite Harbor dock on the north shore of Lake Superior bound for the steel plants in the east. Discussion of these details is beyond the scope of this article, but a brief description of the basic formation, namely taconite, is pertinent to any consideration of the blasting problem.

Where is Taconite Found?

Taconite is the local name for the original so-called Biwabik iron formation comprising the Mesabi Range and it was from this deposit that the rich direct shipping ores were formed millions of years ago by nature's leaching processes. The Range is located about 75 miles north of Duluth and it extends about 100 miles east and west. The outcrop is relatively narrow ranging from only one to three miles in width. Only the eastern half of the deposit is of interest for purposes of this article since it is mainly this portion which contains the raw material commercially



The taconite deposits in the Biwabik iron formation are known as lower cherty, lower slaty, upper cherty and upper slaty. In these horizons, the variations in structure and mineral content have an important bearing on blasting characteristics

adapted to the magnetic process now in use.

In order to be acceptable, taconite must first contain magnetic iron ore, or magnetite, in the proper concentration. Also, the other minerals composing the formation, such as quartz, silicates and carbonates, must be in such form that the magnetite can be separated with the total required stages of crushing and pulverization and will still produce a commercial product at a profit. This final grinding operation reduces 90 percent of the material to minus 325 mesh. In order to provide an acceptable furnace product, this very fine high grade ore must be pelletized.

Because of strict specifications, all of the raw taconite on the Range is not usable and only a limited number of areas thus far are being exploited, three of these being the one at Mountain Iron operated by U. S. Steel, one at Hoyt Lakes operated by Erie, and one at Babbitt operated by Reserve Mining. Other areas may be developed later. Geologists estimate that the total reserve of usable material on the Range may be as much as five billion long tons.

In the blocky material in Area 2, holes are loaded to within four ft of the surface in order to reduce the upper chunks to manageable size and produce sufficient disturbance for efficient shovel operation

Structural Variations Greatly Affect Blasting Characteristics

The taconite deposit is composed of several different zones or horizons and dips gently to the south at six to seven degrees except for certain local variations. These horizons vary greatly in structure and mineral content. This in turn has an important bearing on blasting characteristics including both drilling and fragmentation. The zones composing the taconite deposit are known as lower cherty, lower slaty, upper cherty and upper slaty.

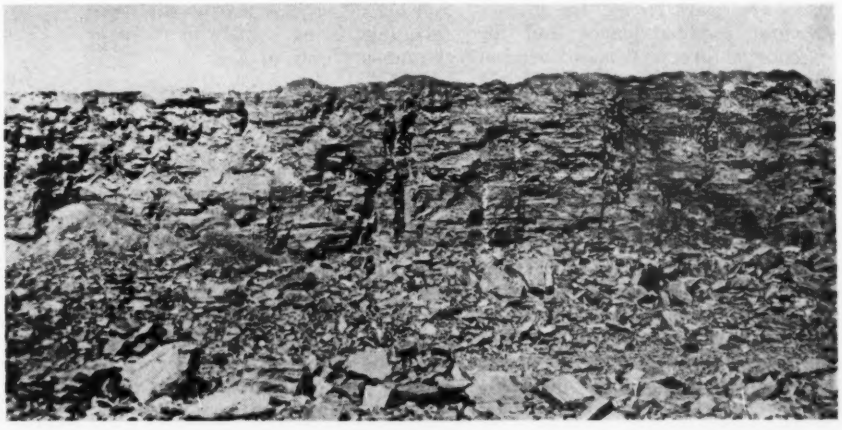
Referring now only to the Erie operation, the lower cherty has been developed most widely and thus far is most productive. However, the upper cherty has been opened up in one area with good results and will occupy a much more prominent place in Erie's future developments. Incidentally, Reserve Mining's operation a few miles to the east is located almost entirely in the upper cherty.

The lower slate layer overlies the lower cherty at Erie to some extent. This layer is not adaptable to the magnetic process. Accordingly, it is being stripped off to the economical limit and stockpiled. The upper slaty occurs to a very small degree and at present this layer is not considered acceptable.

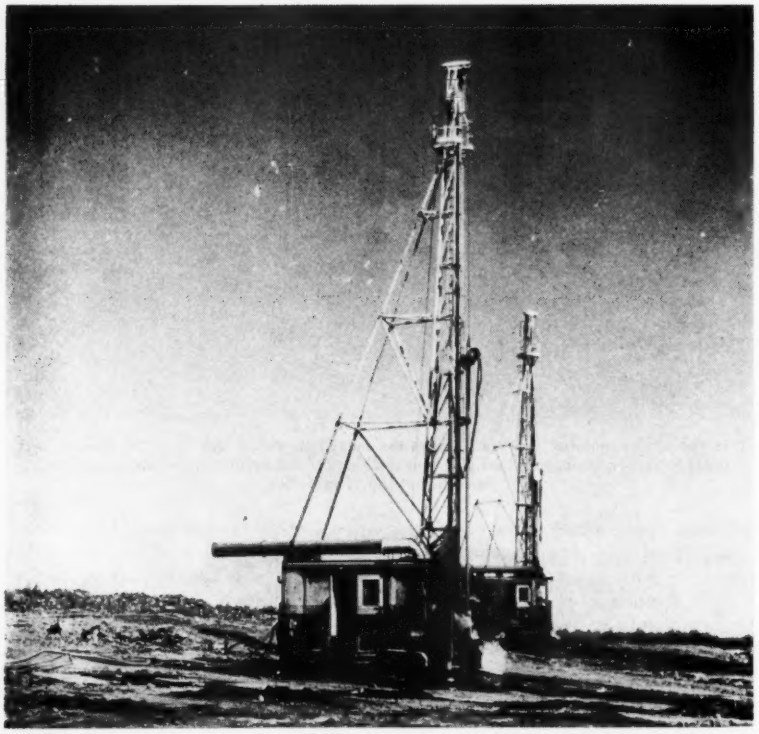
The magnetic iron content of the usable taconite ranges from less than 15 percent to a high of 28 to 29 percent, averaging around 22 percent. The specific gravity averages about 3.45 giving a weight of 215 lb per cu ft or 10.4 cu ft per long ton. A figure of 11 cu ft is used in tonnage calculations. Although the chemical composition of the taconite in the various areas of the Erie pits is quite uniform, there is a wide variation in structure and the prominence of bedding planes and vertical joints. It is these factors that have such a profound influence on drilling and breaking characteristics.

Erie Producing Up To 70,000 tpd

The Erie operation comprises two separate pit areas, No. 1 and No. 2, with crushing, screening, concentrating and pelletizing units located between. The pits are worked in benches and the raw material hauled in 100-ton, standard-gauge, side-dump cars. The benches are relatively low, typical of Mesabi Range open pits. They are nominally 45 ft high by several thousand feet long with certain variations due to local conditions. There are 11 operating shovels of the 190-B class equipped with five cu yd buckets. Recently two to eight yd buckets have been installed experimentally on taconite shovels with excellent results thus far. The raw material production ranges from 65,-



The wide variations in structure and prominence of bedding planes and vertical joints in the various areas of Erie pits have a profound influence on drilling and breaking characteristics



Jet piercing is the only practical means for producing blast holes at Erie. With the piercing method, by making more than one pass with the burner, the holes can be chambered to permit heavier bottom loading in hard ground for shearing the floor

000 to 70,000 tons per 24 hr, three-shift operating day.

In order to permit a realistic understanding of the blasting problem, a brief description of the taconite structure in the respective areas is fundamental. Since the formation pitches slightly from north to south, the lower cherty is found outcropping on the north and composing the 1725, 1670 and 1625 benches. This material lies in the middle part of the lower cherty horizon. In this pit it is characterized by very hard, massive ledges and pre-formed blocks. These are characterized by absence of close bedding planes and the presence of three systems of vertical intersecting joints that are long and continuous. In addition, this blocky condition extends entirely up to the surface of the bench making this, all in all, the most difficult blasting problem at Erie.

Proceeding southward, we cross the lower slaty horizon, part of which is being removed, and then enter the upper cherty where we have the 1625 south and a new bench, the 1590. Although similar in magnetic iron content and minerals, the structure is found to be quite different. Bedding planes are more in evidence and vertical joints much closer and less continuous. As a result, primary blasting is not so difficult although still a problem. Here somewhat larger drilling patterns can be used and by the same token lower explosives ratios.

The material in Area 1, although only two miles distant, is still different in structure, which has an important bearing on both drilling and blasting characteristics. Although entirely within the lower cherty horizon, the material tends to be somewhat softer in most areas and thus drills more readily than in Area 2. Bedding planes are quite prominent and blasting characteristics are more favorable, being similar to those in the upper cherty in Area 2.

Small Blast Holes, Close Spacing Impractical

It should be borne in mind, however, that blasting requirements in the Erie pits as a whole are as severe as found in any other open pit operations in the country or perhaps the world. In the Erie experimental pit opened in 1948, it was determined conclusively that the jet-piercing or spalling process provided the most practical means of producing primary blast holes. However, there has been almost continuous testing of other types of drills.

The jet holes at Erie average nine in. in diameter which in turn require a relatively large drilling pattern. Deck loading of the charge is impractical which means that the blast hole must be entirely filled with explosives.

The crux of the problem then, in massive, pre-formed material such as that in Area 2, is to produce acceptable breakage with widely spaced large diameter holes. If it were practical to drill small diameter holes on close spacings, the problem would be greatly simplified. Under the circumstances, the only alternative is to load heavily with the most suitable type of blasting agent, build the column load close to the surface and utilize the most effective short interval delay pattern.

The blocky material in Area 2 is loaded within four ft of the surface and in other areas, even in the easier shooting materials, five to six ft from the top. This is necessary in order to reduce the upper chunks to manageable size and to produce sufficient disturbance of the material in the blast for efficient shovel operation.

Loading ratios are relatively high ranging from 1.4 lb per cu yd to over 2.0 lb per cu yd. These ratios have been found to be the most practical from an over-all standpoint and to produce best efficiency to date throughout the operation. Because of such heavy and high column loading, fly rock is excessive by normal standards but must be tolerated at Erie.

Another important factor influencing blasting requirements is standard gauge track haulage. This means that preparation must be adequate so the shovel can continue through an entire cut without interruption.

Chambered Holes Permit Heavy Bottom Loading

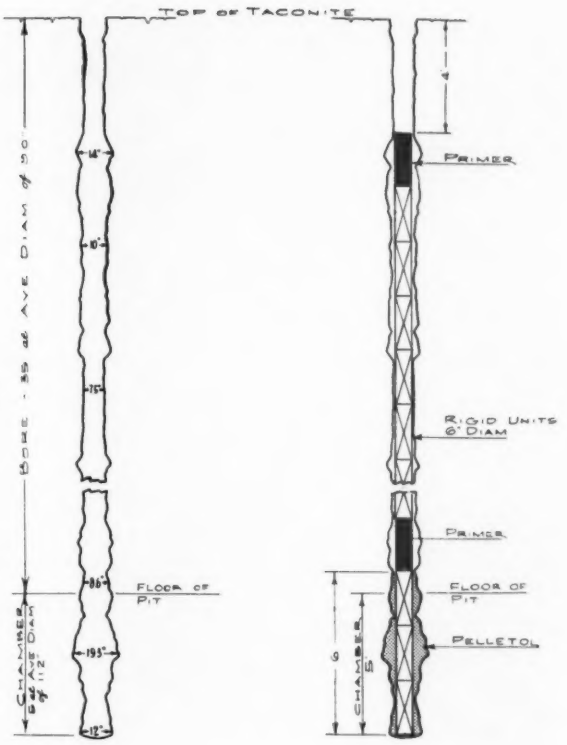
As previously mentioned, jet piercing is the primary method for primary blast hole production. Erie has 12 of these rigs in operation. With three years of rather intensive development, a blasting system has been designed around these nine in. blast holes with surprisingly good results.

As may be known, the jet piercing principle consists of a rotating burner head utilizing oxygen and kerosene to heat the taconite to about 4200° F. Water, fed to the hot rock through

the drill stem, aids in cooling the burner and spalling the rock. It also generates steam which forces the rock fragments out of the hole.

Penetration rates with jet piercing rigs average around 70 ft per eight hr shift in the hard, siliceous taconite in Area 2 to as much as 200 ft in the more highly carbonaceous taconite in Area 1. These rates include moving and settling up. Actual penetration ranges from 12 ft per hour to 30 ft per hour respectively. Penetration rates are reduced by 10 to 20 percent in shattered or seamy ground, such as the back break area (if there is any) from the blast in front.

A supplementary advantage to the piercing method is the facility for enlarging the hole at the bottom where needed, by making a second or even third pass at any desired rate. This chamber permits heavier bottom loading in hard ground for shearing the floor. At present, all blast holes are sub-drilled a standard distance of five ft below the pit floor. The practice is to chamber the sub-drilled portion of all taconite blast holes in Area 2 and only the rear holes of the patterns in Area 1. This is another indication of comparative blasting characteristics in the two locations.



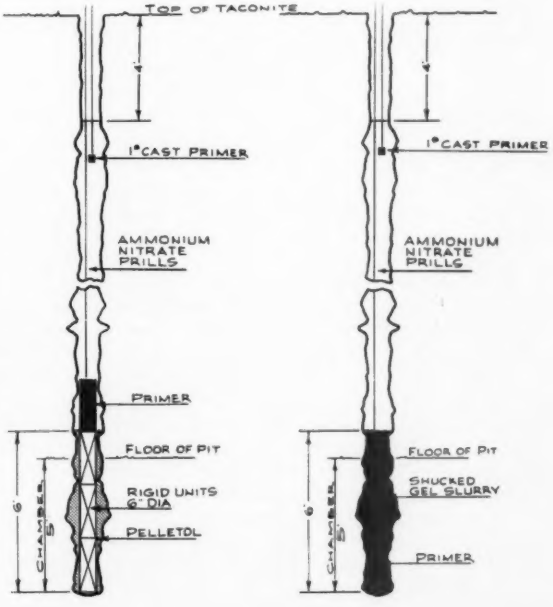
The original practice in blasting procedure involved the use of six-in. diam rigid explosives that occupied only about 45 percent of the hole volume. With this system, fragmentation was inferior and considerable secondary blasting was necessary

Irregular Blast Holes Aggravate Loading Problem

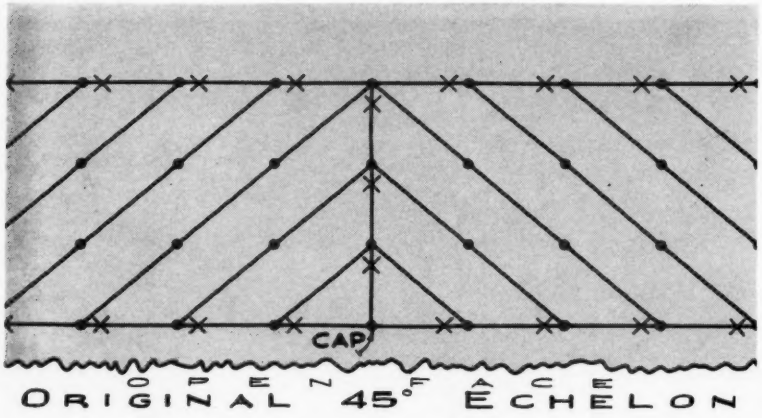
A jet piercing rig produces a very rough or corrugated hole due to the unequal rates of spalling in passing through the various mineral layers in the taconite. Although diameters average about nine in., the minimum is 6½ in. and the maximum has been measured at as much as 18 in. This condition aggravates the loading problem and influences choice of explosives. It is imperative for best results to fill the entire hole volume including the irregularities, regardless of blasting material used.

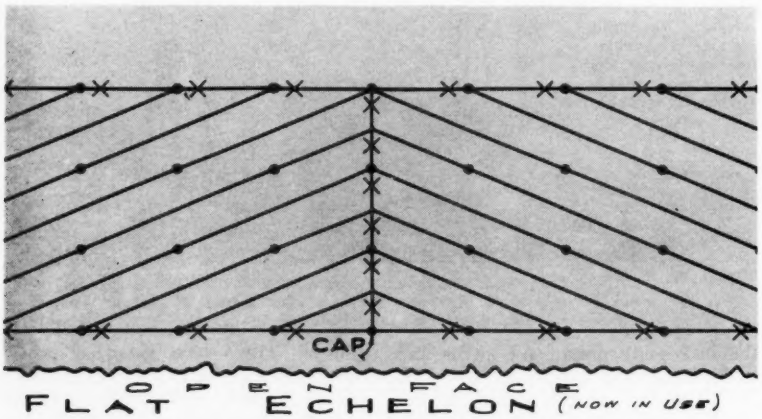
Originally, Erie used mostly rigid units of high grade explosives. The space around the column in the bottom chamber was filled with a waterproof high-cost free-flowing material called Pelletol. Otherwise, the annular space around the six in. diam column was left open and this meant that only 45 percent of the hole volume was being utilized. Except in Area 1, where it has always been good to excellent, fragmentation was inferior and considerable secondary blasting was necessary in order to reduce chunks too large for the drop ball.

A program of experimentation was instituted in 1957 coinciding with the increasing use of AN prills and the introduction of similar low cost free running materials by the explosives companies. Many test blasts were made covering a period of many months. These tests involved every conceivable combination of blasting materials that offered any promise of improved breakage and lower blasting costs.



(Left) Column loads of ammonium nitrate prills and fuel oil provided good costs and improved breakage. (Right) Recent practice has been to use shucked gel slurry for the bottom loads. When long term exposures are anticipated, the slurry is used intact in plastic bags





The flat echelon hook-up is more effective and simpler than the 45° echelon hook-up originally used. With the 45° echelon arrangement there was a greater potential for cut-off holes

Use of AN Prills and Fuel Oil Limited to Dry Conditions

Blasts were analyzed from the standpoint of observed fragmentation, shovel performance as determined by time required to load eight car trains, and by secondary costs. All of this involved study led to the definite conclusion that lowest primary cost plus best breakage was produced by column loads of AN prills and fuel oil.

Improvement throughout was very impressive. However, prills have the disadvantage of being incompatible with water which has limited their use to dry conditions. In order to guard against loss of charge from surface run-off during melting or rainy weather, a water resistant free-running blasting agent is supplied by the manufacturer. However, this cannot be loaded into standing water so here it is necessary to resort to the higher cost water-proof materials at a sacrifice in performance.

More recently the rigid bottom load with Pelletol has been replaced by shucked slurry at a substantial decrease in cost per pound. This material is subject to erosion by moving or dynamic water but thus far experience at Erie has been very satisfactory with exposures as long as three weeks. For longer periods the slurry is used intact in the plastic bags surrounded by Pelletol in the chamber. When the charge has been built up above water, then prills are loaded.

Another category of experimentation has been the short interval delay period between holes and between rows. The standard pattern has long been 20 ft burden by 22 ft spacings for hard blasting materials and 20 by 24 respectively for easier shooting. A few months ago when there appeared to be over-blasting in Area 1, drill hole patterns were increased to 21 by 26 with apparently satisfactory results. The nominal blast is four rows or 80 ft wide although this has varied on special occasion up to six or nine and down to two or three rows.

The original delay and Primacord hook-up was with 17 milli-second connectors between the 45 degree echelon cords. It was observed that back break was excessive with a minimum of forward movement of the blast. Longer delays were provided by introducing the milli-second connectors into the echelons with immediate improvement in performance, less back break and better breakage. However, it was found that this system was laborious to hook-up and increased the potential of cut-off holes. It was accordingly replaced by the flat echelon which is much simpler and more effective.

Best Performance Achieved with Long Delays

The thesis with respect to short interval delays has been to introduce into the blast pattern as much delay as possible without risk of cut-offs from ground movement. Such cut-off potential is greater in massive, blocky ground than in stratified, closely jointed material. It must be understood that delay action is being achieved by surface hook-up rather than by delay caps within the charge. However, it is quite generally accepted that the longer the delay between holes and between rows, the less the back break and the better the over-all performance. It has been found accordingly that in Area 1, due to the taconite structure 34 MS can be used between rows. As opposed to this, delay is limited to a maximum of 26 MS in the blocky portion of Area 2.

It is generally agreed that much of value has been done during the three year period of development and experimentation to augment earlier accomplishments. However, a study of drilling patterns was recently started since this phase of blasting had been held fairly constant while investigating other aspects of the problem.

Any conclusion in the field of drilling pattern must obviously be held in abeyance for many months to come. Also because of varying conditions continually being encountered in the pits and innovations in the category of blasting materials, the program of experimentation and study must be continued to try to achieve optimum performance. The safest attitude for the guidance of blasting activities is to consider every blast as experimental, which makes it difficult ever to achieve what can be accepted as ideal performance.

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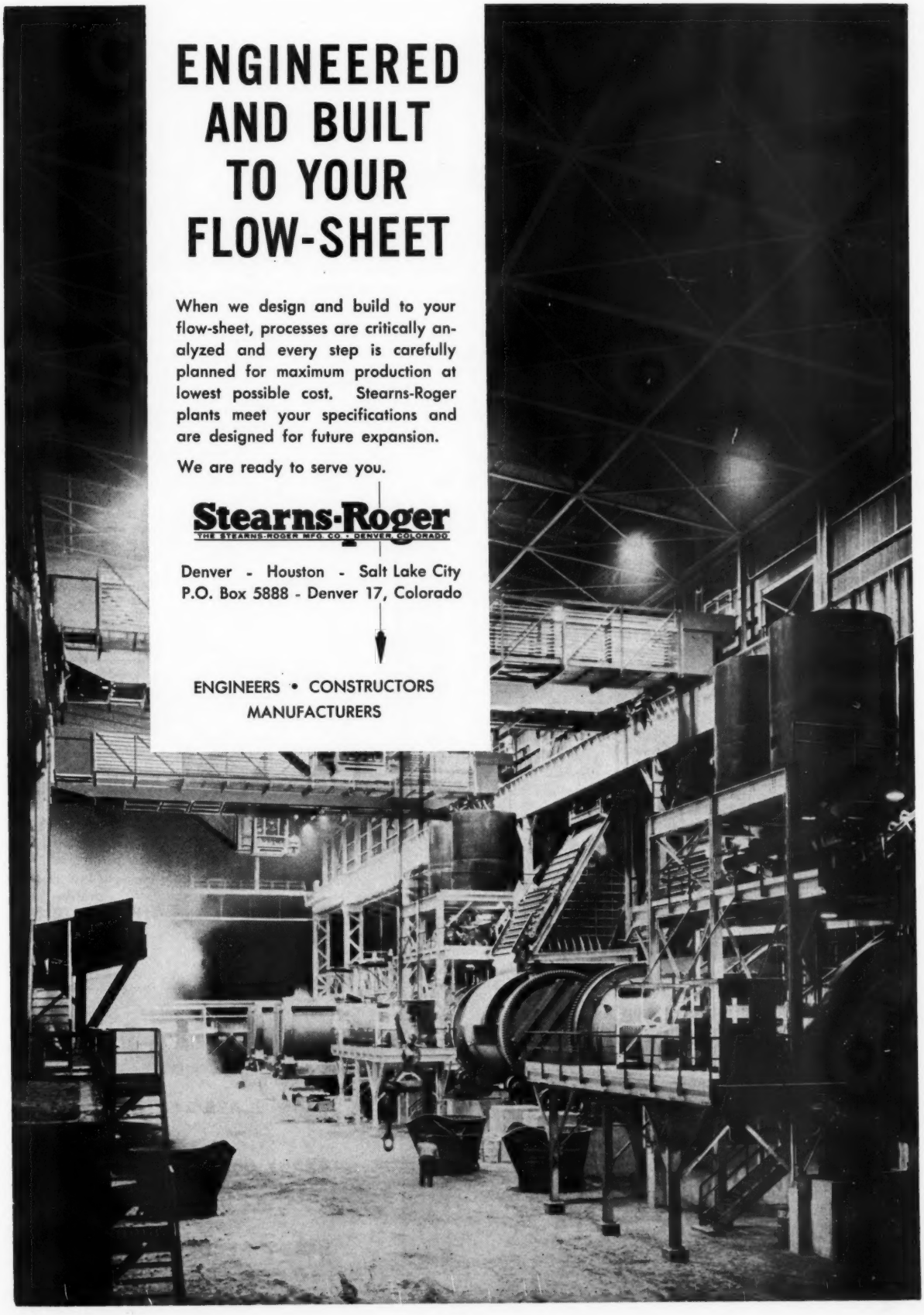


Continuous Mining in Thin Seams

By NORMAN YARBOROUGH
General Manager
Harlan Fuel Co.

HARLAN Fuel Co., a partnership, operates coal mines in the middle split of the Harlan seam and the Darby seam at Yancey, Harlan County, Ky.

All coals produced at these mines are marketed under the trade name "Yancey" by Randall Fuel Co., Atlanta, Ga.; Republic Coal & Coke Co., Chicago, Ill.; and Bursick Coal Co., Detroit, Mich.

The company's average mine production of 1500 tpd of clean coal is processed into five grades for the domestic market. The grades and methods of cleaning are:

1. Plus 6-in. block, hand-cleaned
2. 3½ by 6-in. egg
3. ⅞ by ⅜-in. stoker
4. ⅝ by ⅜-in. stoker (The egg and stoker are washed in a Daniels dense media vessel at 1.50 gravity)
5. Minus ⅜-in. carbon, tabled over three double-deck Deister tables and mechanically dried by a C.M.I. dryer

Faced with diminishing reserves in the Harlan seam, the decision was made in early 1950 to enter the Darby seam. Very little information was available concerning the characteristics of this seam on Harlan Fuel's property, or its marketability. Extensive mining of the Darby seam had been done on surrounding properties, with their products achieving a premium status on the domestic market. Column samples of the seam, taken near the outcropping, were analyzed. While a single conventional off-track unit advanced development headings, mine run sample analyses were taken. This production was marketed as an industrial coal until sufficient analyzing and field experience in small stoker units proved this coal to be equal, or superior, to the premium products sold under the trade name "Yancey".

Composite analyses from commerical testing laboratories revealed the following results of the ⅞ by ⅜-in. stoker coal:

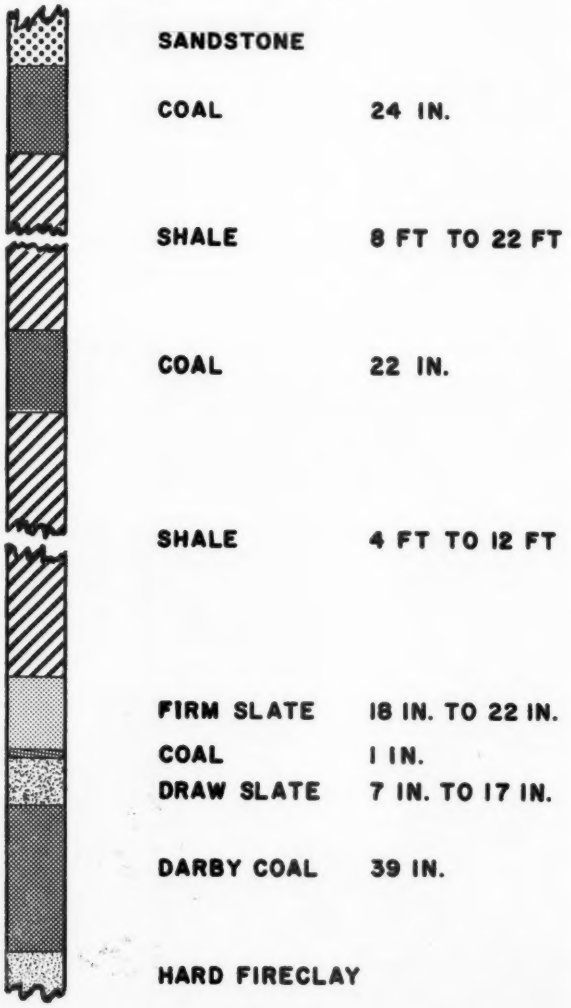
Ash (dry basis)	2.70
Percent volatile	37.31
Sulphur	0.69
Carbon	59.99
Fusion temp.	2,340°F
Btu	14,454

One big hurdle, market acceptance, was cleared; however, the next major obstacle, economically mining the seam at a cost that would justify the attacking of 6000 acres, or 15,000,000 tons, of Darby coal on Harlan Fuel's property, provided management with a multitude of problems.

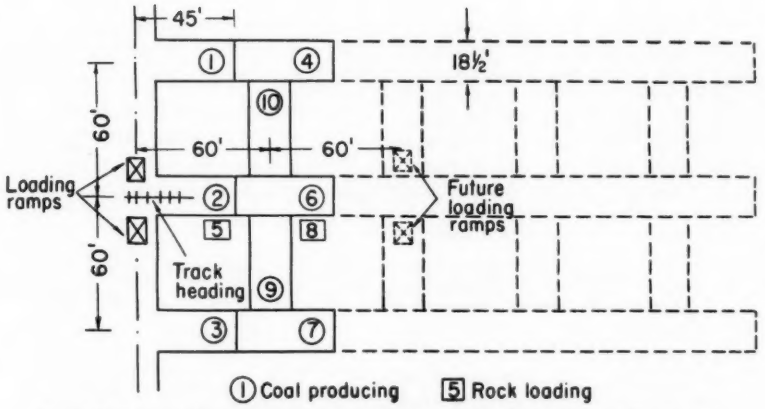
Roof Control a Factor in Selection of Continuous Miner

Historically, the Darby seam in the Harlan coal beds has a weak roof structure. With conventional off-track mining equipment and blasting, several factors soon became apparent. They were:

1. Normally, the draw slate would stay intact for two cuts, or approximately 16 ft.


SANDSTONE
COAL 24 IN.
SHALE 8 FT TO 22 FT
COAL 22 IN.
SHALE 4 FT TO 12 FT
FIRM SLATE 18 IN. TO 22 IN.
COAL 1 IN.
DRAW SLATE 7 IN. TO 17 IN.
DARBY COAL 39 IN.
HARD FIRECLAY

Typical geological section of Darby seam. The draw slate is controlled with 30-in. roof bolts anchored in the 18-in. shale



The preliminary mining plan, approved by the State of Kentucky, allowed for crosscuts on 90-ft centers. However because of the weak roof it was necessary to alter the plan and place crosscuts on 60 ft centers

2. The 18-in. firm blue slate provided an excellent roof except in certain areas where cutters and rolls tended to allow air slackening of the shale.
3. Once the 18-in. shale was broken, the roof normally could not be maintained until an arch was formed to the first coal seam, due to constant spalling from the arch, caused by air slackening. Only slight improvement of this condition is achieved with roof bolting.
4. The draw slate immediately overlying the coal responds to roof bolting, provided anchorage is in the 18-in. shale. Therefore, a 30-in. roof bolt was adopted as standard where it was desirable to maintain the draw slate.

It was believed that continuous mining would improve the roof control problem. However, the economic factors of the necessary capital expenditures were to be reconciled before a final decision could be made to move to continuous mining. The size consist of the coal produced with continuous miners and its effect on an already diminishing graded coal market and product realization had to be considered.

Field surveys of continuous miners were made by Harlan Fuel's management. During these surveys, a prototype Compton CU41 miner was viewed at a mine in the Dean seam in Tennessee. The management team was impressed by its productivity, size of product, effects on the roof, small quantity of coal dust in suspension, simplicity of operation, and the lack of vibration of the machine during its unique cutting cycle.

After careful consideration of all the operational and engineering features, the decision was made to purchase a CU42 miner.

Underground Movement of Machine Solved

The CU42 miner arrived at Harlan Fuel's property late in September 1960. Transfer of the machine underground was immediately begun. Forty-eight man-shifts were required to transport the intact machine from the portal to the working face. The miner was transported on a lowboy carrier. Elzo mine had previously been a 100 percent d-c installation. During the movement underground, 440 a-c power was not available to maneuver the machine through limited clearances. This required the removal of timbers, trimming of ribs, and resetting the d-c power trolley wire. This has been the only disadvantage experienced by using a-c power.

Critical features of the miner that hampered the movement underground were: Over-all height of lowboy hauler—41 in., Width with heads close—10 ft, Length with heads close—33 ft and Weight—20½ tons. Other specifications and features of the CU42 are:

- Over-all height 32 in. with five-in. ground clearance adjustable to 30 in. with three-in. clearance
- Cutting width—18 ft 6 in.
- Power—440 volt a-c
- Conveyor width—25 in.
- Motors—two 100 hp
- All drives hydraulic, eliminating drive shafts and clutches
- Unitized subassemblies for simple maintenance
- Variable speeds with hydraulic valving
- Power divided equally between each half of machine for balance
- Opposing workloads on cutterheads create stability

Previously, permits had been obtained from the Commissioner of the Department of Mines & Minerals of the State of Kentucky to cover power distribution and a mining plan to permit 90-ft crosscut centers.

Mining Plan Selected

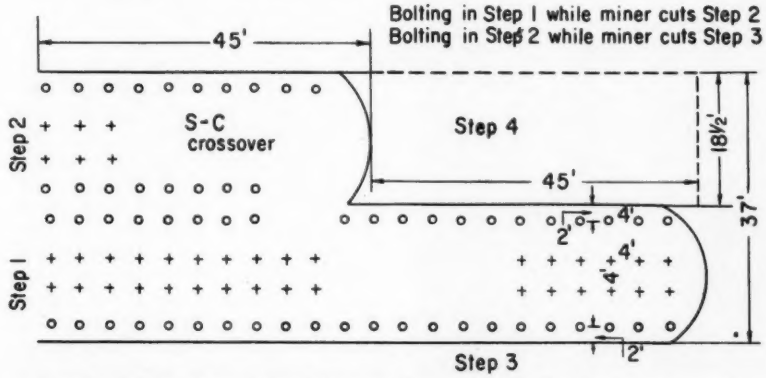
In theory, a production of two tons per ft of advance could be obtained in a 39-in. coal height.

A mining plan was designed to minimize moving time of the miner, 90° angle turns and shuttle car haul time. However, the weakness of the 7 to 17 in. draw rock necessitated modifying this plan.

It became apparent that a 45-ft advance under the draw rock was the safe limit without roof bolting, and the mining plan was altered to provide for a 45 ft advance, then a move to the next place to allow roof bolting.

The initial work done with the miner was advancing five headings in 1 haulage west, a main cross entry. After advancing these headings 600 ft, the miner was moved to turn 5 right butt entry. This entry was for room and pillar development and projected to be driven 1800 ft on a three-entry system with rooms right and left on 50-ft centers. Room and pillar extraction was to be on the retreat. Rooms were projected for two passes by the miner and the removal of the 14-ft pillar.

Roof deterioration prevented the installation of this plan because only



The safe limit for advance before bolting was found to be 45 ft. The miner then is moved to the next place and the 18 in. of draw slate is bolted

one pass could be made in the rooms and only limited punching on the pillars was possible.

Under all of Harlan's mining plans, the miner has dumped the coal on the footwall for transloading with a 14BU Joy loader into two Joy 8 SC shuttle cars. The shuttle cars dump directly into two-ton Sanford-Day drop-bottom mine cars. Easily moved, two-piece skid type wooden ramps are used at the loading point to elevate the shuttle cars.

Track haulage is straight push-pull, utilizing a Brown-Fayro hoist for pulling the 15-car trips past the loading point on both advance and retreat.

The crew consists of

1—Miner operator, 1—Loader operator, 2—Shuttle car operators, 2—Roof bolters—timbermen, and 1—Foreman.

The miner is operated two shifts per day, and two repairmen service and repair on the third shift. The crew handles its own change-out of trips. This crew is self-supporting except for extending or retracting track and wire and preparing the boom holes.

Moves are made on shift at each 120 ft of advance or retreat in cross entries and each 180 ft in mains.

The timbering plan is a row of wooden timbers three ft from each rib with two roof bolts on four-ft centers in the middle of the work place. All roof bolting is done with a Chicago-Pneumatic rotary drill.

Modifications Improve Operations and Reduce Maintenance

Similar to all other new mining equipment, weaknesses and "bugs" have developed. Oil leaks, heat, and mechanical failures of components have been the major problems.

The closed hydraulic circuits that power the cutterheads at a maximum 3000 psi have been the primary cause of oil leaks and oil usage. Proposed design changes which will replace the closed hydraulic circuits with two direct drive a-c cutterhead motors will eliminate this problem.

Redesigned heat exchangers, along with an improved spray system, have improved the heat problem; however, the removal of the closed circuits and conversion to electrically driven cutterheads will eliminate it.

Bracing of the hinge pins, heavier metal and welding, and a proposed redesign of the conveyor head should eliminate the remaining mechanical weaknesses.

Oil usage has been excessive because of abnormal leakage. It was not uncommon to use up to 110 gal of hydraulic oil per operating shift until a redesigned piping system utilizing Aeroquip Co. equipment was installed in December 1960.

Cutter bit cost has been 10.6 cents per ton; however, this figure has been unduly inflated by the initial stocking cost and, for a short period, because of a mechanical maladjustment, the cutterheads were coming into contact with each other and destroying the bits. There are indications that the unique cutting and breaking action of this miner will result in a much lower bit cost than with other types of machines.

Confidence in the engineering ability of the manufacturer, size consists that are equal to conventionally mined coal, and elemental time studies have convinced management that this machine is well worth the pains of development.

Continuous Miner Produces Over 300 Tons Per Shift

Time studies for a 20-shift composite in advance work showed the following mining rates:

1. *Cycle Time*

	Elemental Time—Minutes
Sump	0.25
Sweep No. 1—top	1.10
Open heads No. 1	0.11
Sweep No. 2—bottom	0.54
Open heads No. 2	0.11
Total average cycle time	2.11

2. Cycle tonnage:
   Height of 2 sweeps × depth of sump × width of cut × conversion factor = tons
   40″ × 14″ × 18′ 6″ × 0.04 = 2.88
3. Mining Rate:
   Tons per minute = $\frac{\text{cycle tonnage } 2.88}{\text{cycle time } 2.11 = 1.36 \text{ tpm}}$

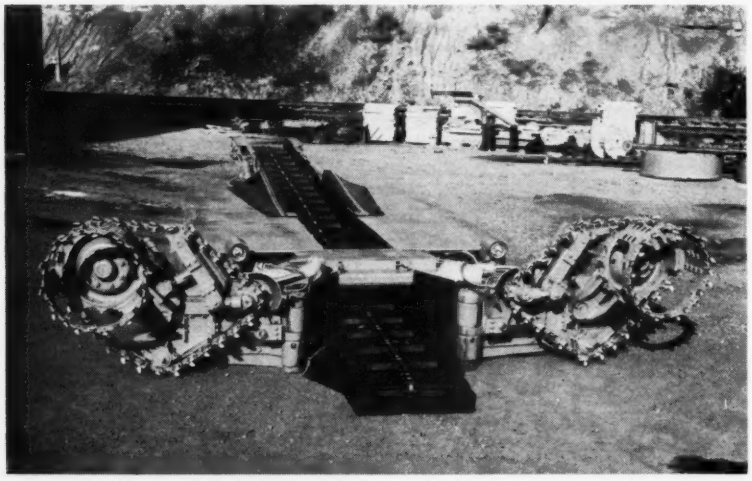
These studies also sustained the manufacturer's recommendation that the sump depth with the machine be limited to one-half the diameter of the cutterheads to allow free flow of coal through the cutterheads. The projected 300 tons per unit shift has been attained sporadically. The best performance to date has been 342 tons per shift.

The size consist of the coal, while comparing favorably with conventionally mined coal, has not been as favorable as expected. One sample taken on the butt cleats, with a grindability of 45, gave the following screen results:

	Percent
Plus 6 in.	1.97
6 by 2 in.	20.95
2 by ¾ in.	22/23
¾ by ¼ in.	23.90
Minus ¼ in.	30.95

Visual inspection indicates that the top sizing is better on advance work than on retreat work. Cycle time on retreat work is much faster.

Full pillar extraction, under Elzo's present mining conditions, is impracticable with this machine. The required working width creates roof spans that cannot be supported in the weak, quick-breaking roof of the Darby seam. A set of room pillars was extracted in February 1961, for experimental purposes. The wing and pocket system was used. In both cases, the pocket collapsed before the eight-ft wing could be extracted; therefore, the system of two passes in the rooms, with punching of the pillars, where practicable, has been adopted.



The new miner has a unique new cutting motion with two hinged augers. The lack of vibration and smooth operation recommended it for good roof control

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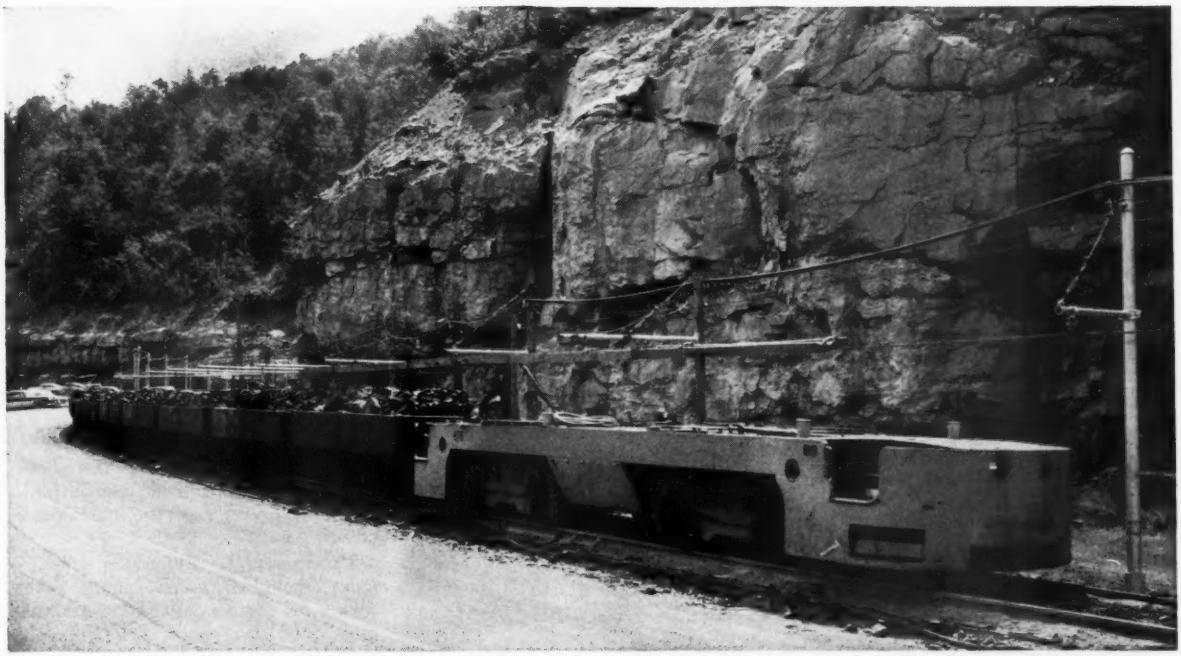
Other features of 8-wheel locomotives and other types for mainline and secondary haulage are described in Catalog 958. For a copy, write to The Jeffrey Manufacturing Company, Columbus 16, Ohio.



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JEFFREY

Aerial view of the Anaconda Reduction Department shows the slag disposal area (lower right), flue system (center), No. 1 tailings pond (lower left) and hydroseparator and thickener (left center)

Disposal of Metallurgical Wastes

By FRANK H. DAY
General Superintendent
Anaconda Reduction Department

Waste materials at Anaconda are disposed of safely, at the lowest possible cost and with a minimum of nuisance to the population

THE Anaconda Reduction Department of The Anaconda Co. is located just east of the city of Anaconda, in Deer Lodge County, Montana. Plant elevation is between 5000 and 5800 ft. The climate is temperate in summer, and can be severely cold in winter. Present employment consists of 1350 smelter workers, 550 craftsmen, and 330 salaried employes.

Wastes Include Gases, Liquids and Solids

The copper circuit of the plant processes sulphide ore through concentration, roasting, reverberatory smelting, converting, and casting, to anode copper, with a normal capacity of about 25,000,000 lb of copper per month.

There is a zinc mill with a capacity of 4000 tpd of ore, followed by Fluo-Solids roasting, leaching, and electrolyzing plants, which have a capacity of up to 15,000,000 lb of Special High Grade zinc per month. At present, because of the condition of the zinc market, the zinc circuit is not in operation.

The manganese circuit processes carbonate ores through concentration and calcination to produce nodules which are treated in electric furnaces to make ferromanganese. Capacity of the ferromanganese plant is 3000 tons of 80 percent Mn ferro per month. Zinc and lead concentrates are a by-product of the manganese circuit.

Previously the Reduction Department included a phosphate plant with a productive capacity of 100,000 tons of fertilizer per year. This plant has been sold, dismantled, and moved to another location. However, the sulphuric acid plants remain intact, and can be used up to a maximum production of 450 tpd of 100 percent H_2SO_4.

It is with the waste products resulting from the treatment and production of these materials that this article is concerned.

For the purpose of this article, metallurgical wastes will be considered products of metallurgical operations which cannot be sold for more than the cost of removing them from the circuit. At Anaconda, the principal waste products are: reverberatory slag, flue gases, mill tailings, and mine water from the Butte Mines Precipitating Plant which is channeled through the Anaconda tailings disposal system for neutralization and clarification.

High-Velocity Water Jet Granulates Slag

Anaconda differs from most copper smelters in that the slag is granulated and sluiced away from the furnace, rather than being trammed to the dump in a molten condition. The slag is skimmed through a bay in the front wall of the furnace, and drops into a high velocity jet of water which effectively granulates it. Most of this material would pass a 10 mesh screen. Oversize pieces are removed by a 1½-in. grizzly and those that contain sufficient copper values are charged back into the furnaces. Additional water is added to sluice the granulated material through the launder which carries it to a series of drop boxes and collecting launders which, in turn, deliver the slag to the decant ponds.

There are two decant ponds, each of which will hold up to 1500 tons of slag. The slag settles rapidly in these and the water overflows to a series of four settling ponds to allow for removal of a small quantity of suspended material before the water is pumped back to the reverberatory furnaces for reuse in the granulating operation.

When one decant pond is filled with slag, the incoming stream is diverted to the other pond, and the filled pond is allowed to drain. Drainage is accomplished by allowing water to seep through a gravel bed at the lower end of the pond. A pond will drain dry enough to be handled in eight hours or less.

Slag is removed from the ponds by a four cu yd drag scraper operated by a double-drum hoist driven by a 100 hp motor. The tail sheave is changed from one pond to the other by a motor-driven trolley running on a monorail. Up to 1500 tons of slag can be removed from a pond during an eight-hour shift.

The drag scraper pulls the slag up a rail-covered incline to a grizzly located at the lower end of each decant pond. Under each grizzly is a small surge bin and a feeder belt which delivers the slag to a 500-ft horizontal conveyor leading to the disposal area. There is an automatic belt scale on this belt, and an automatic sampler is located in the transfer chute under the head pulley.

Slinger Distributes Slag on Dump

At this point the slag is transferred to a belt inclined upward at 15° to give elevation to the slag before slinging it out on the dump by means of a Swivel Piler. At present, this conveyor is 520 ft long and 130 ft above the top of the old slag dump.

The Swivel Piler, or "slinger" as it is commonly called, is a 16 in. wide belt, 100 in. long, driven at a speed of 3600 fpm by a five hp motor. It imparts sufficient velocity to the granulated slag to carry it out to a 50 ft radius from the end of the conveyor. The inclination and direction of the slinger can be altered to direct the stream of slag to any point within its range.

The conveyor and slinger installation was designed to replace an older system in which the slag was sluiced over a trestle to the disposal area, decanted in tanks, and loaded by a clam shell bucket into side-dump cars. These cars were hauled by electric locomotives and dumped around the ever-increasing periphery of the dump. The old system required excessive manpower for both operation and maintenance, and a substantial decrease in slag disposal costs was made with inauguration of the new system.

However, an improvement is being made in the new system which will result in a further reduction of disposal costs. This consists of a portable 100 ft conveyor to which the slag can be dropped from the inclined conveyor. Placing the slinger on the end of this conveyor will result in a pile three times as wide as the pile now being built from the inclined conveyor by the slinger.

The inclined belt has been extended to the limit of the horsepower of the drive motor. To avoid installation of a second inclined belt at this time, bulldozers are being used periodically to remove the piles of slag which build up under the slinger. Consideration is being given to the possible use of a dragline to remove these piles and deposit the slag some distance away from the head end of the inclined belt.

Labor requirements beyond the furnaces consist of an operator on the dragline, and a laborer to clean the conveyor ways and change the direction and inclination of the slinger. This operation works one shift per day. A carpenter and helper are required for 2½ shifts per week for maintenance of the slag launders.

In cold weather, operations are somewhat hampered by freezing conditions. A lump crusher has been designed to break up chunks of frozen crust which sometime form on the decant ponds. At the slinger, infrared heaters are used to keep the moist slag from freezing to the slinger belts and other parts of the machine.

Current costs are well below costs under the old system and are competitive with the cost of tramming molten slag to a dump.

Granulated reverberatory slag is sluiced through launders (lower right) to the drop box feeding the decant ponds. The right hand pond is being filled while a four cu yd scraper removes slag from the left hand pond. Note slinger discharging slag from end of inclined conveyor

Excess Capacity of Flue System Minimizes Stack Emanations

Flue gases from the roasters, reverberatory furnaces, and converters at Anaconda are gathered into flue systems to allow settlement of entrained dust, after which they are channeled to a central flue, treated through electrical precipitators, and discharged to the atmosphere through the "Big Stack." The big stack got its name some years ago when it was not only the largest, but also the highest stack in the world. Since then, many higher stacks have been built, but few, if any, can compete with the Anaconda stack for volume and capacity. It is 585½ ft high, has an outside diameter of 86 ft and an inside diameter of 75 ft at the base. Inside diameter at the top is 60 ft. The stack can handle up to 4,000,000 cfm of hot gases, and it supplies draft for the operation of all the pyrometallurgical processes within the plant.

Branch flues from the reverberatories, converters, arsenic roasters, and copper roasters come together to form the 60 ft main flue which later widens out to form the 120 ft flue. The difference in elevation between the lowest point on the flue system at the converters, to the base of the stack, is approximately 400 ft.

There are 20 units of Cottrell treaters, each with a capacity of 100,000 cfm of gases at 130° F. These hand-wrapped units strip the gases of their dust burden, and so spent gases and water vapor are the final waste products leaving the flue system. Because of improvements in operating procedures, and the large excess capacity of the flue system for present operations, stack emanations have been reduced to practically nothing.

Arsenic and Bismuth Recovered from Dusts

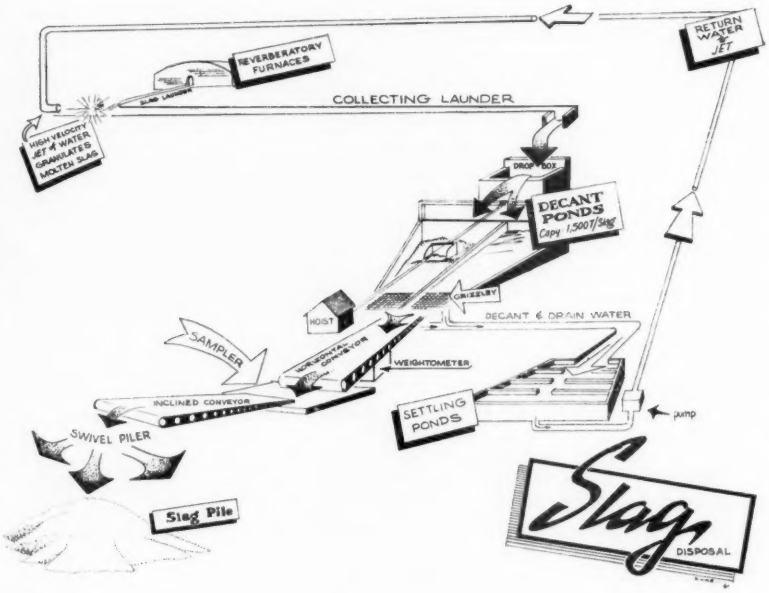
Dust removed from various parts of the flue system are all treated back through the plant. Converter dust and roaster dust are charged into the reverberatory furnaces. Main flue dust is treated for arsenic recovery, with the residue going to the reverbs. Arsenic in the main treater dust is also recovered and the residue from this operation is sent to the Tooele lead smelter for bismuth recovery, after which the copper-bearing portion is returned to Anaconda for treatment in the reverberatories.

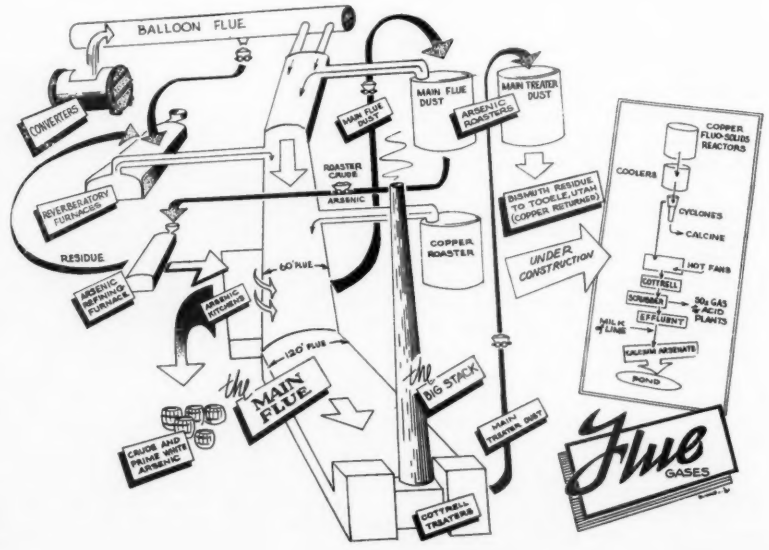
Treatment of flue dust for the recovery of arsenic consists of roasting the material with coal in a hearth roaster and cooling the resulting fume to produce a roaster crude arsenic containing about 85 percent As_2O_3. This material is again roasted in a small reverberatory type furnace and the fume is condensed in kitchens to produce refinery crude and prime white arsenic, both of which assay over 98 percent As_2O_3. These materials, amounting to some 200 tons per month, are sold to chemical, glass and manufacturing companies.

A new copper roasting installation, now under construction, will change the method of removing arsenic from the copper circuit. Gases from Fluo-Solids roasters will be passed through a scrubber where the arsenic fume will be taken into solution. Subsequent treatment of this solution by milk of lime will precipitate the arsenic as calcium arsenate, which will be ponded within the confines of the plant. It is expected that this treatment will reduce the load now circulating through the plant, which will, in turn, improve the quality of the anode copper being shipped to the refinery.

Tailings Disposal Area Will Cover 4200 Acres

After the Anaconda plant was started in 1902, some 81,000,000 tons of tailings were laid down in a





disposal area covering approximately five square miles north of the plant.

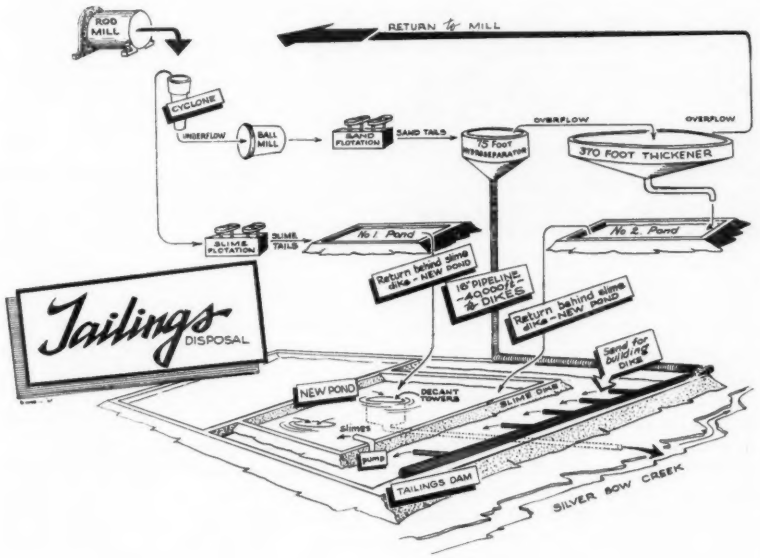
These older areas contained considerable slime, which made continued dam raising unsafe, so in 1946, a new disposal area was started adjacent to the slag disposal area, between the plant site and the Butte-Anaconda highway.

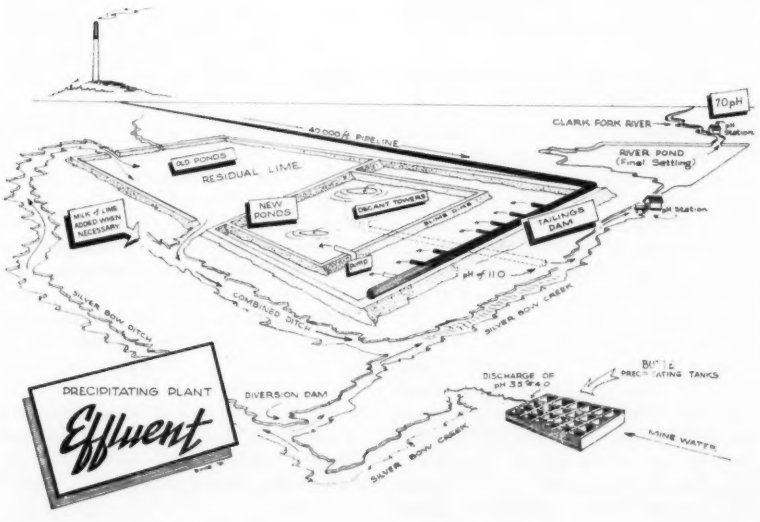
Two ponds, designated No. 1 and No. 2, covering 490 acres, were established in this area. Tailings are discharged from spigots in a 28-in. wood-stave pipe line around the periphery of each pond. In these ponds, sands drop out close to the dikes, slimes carry in toward the center, and clear water overflows the decant towers located at the centers of the ponds. Bulldozers and draglines are used to progressively raise the dikes on each pond, using the coarse material which forms the inside beaches close to the dikes. The 28-in. pipe line is raised along with each eight ft lift of the dikes.

A difference in elevation of 135 ft between the lower end of the mill tail race and the starting elevation of these ponds allows the use of towers to furnish driving head for the tailings through the 28-in. pipe line.

Ponds No. 1 and No. 2 still have capacity for the storage of several years production of tailings and are very much a part of current operations, but since both head and space limitations of this disposal area are definitely limited, preparation of an area which will accommodate tailings for a 25 or 30 year period was started in 1956.

This project consisted of building a dike of country gravel completely around the lower end of the old tailings area as the starting base of a dam which, when raised by sand to a height of 90 ft, will enclose an area of 4200 acres and provide storage for 400,000,000 tons of tailings.





Sands and Slimes Separated in Cyclones

A slime dike, five ft lower than the outside dike and paralleling it on the inside, was built to allow separation of sand from slimes during the initial stages of raising the sand dam. This dike provides a space 500 ft wide in which only deslimed sand is placed, thus insuring the absence of slimy slip planes around the outer portion of the base of the dam.

Under present operations, separation of tailings into sand and slime portions begins in the mill. A cyclone on the rod mill discharge divides it into two parts.

The cyclone overflow, amounting to 30 percent of the feed, and containing the slime from initial crushing and grinding, is sent directly to bulk flotation. Rougher tails from the slime float feed are routed through their own tail race to Pond No. 1. This pond is held at a low level so that the slime tailings overflow the decant tower. The outflow is carried through ditches which terminate behind the slime dam of the new pond.

The cyclone underflow, containing the balance of the rod mill discharge, is fed through the ball mills and then through the sand float sections of the mill. Tailings from these sections of the mill, along with tailings from the regrind and cleaning operation, go to a 75-ft hydroseparator where slimes generated in the ball milling operations are scalped off.

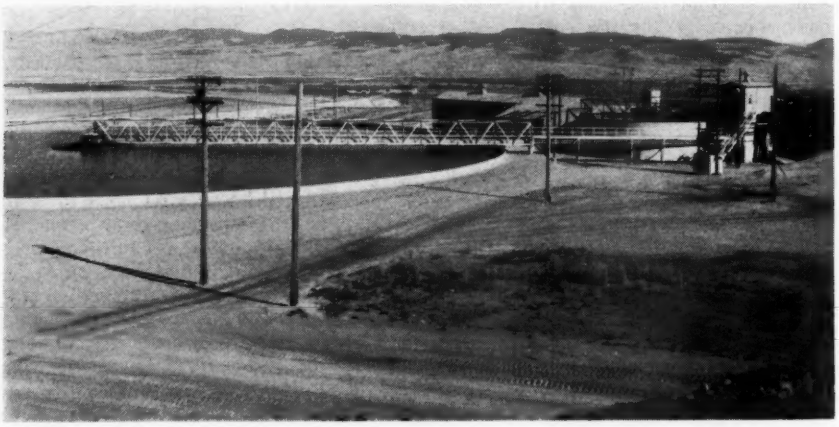
The overflow of the hydroseparator goes to a 370 ft thickener. Clear water overflowing the thickener, and amounting to some 10,000,000 gal per day, is returned to the mill for reuse. The thickener spigot goes through Pond No. 2 and joins the slime tailings in the ditches which place them behind the slime dam at the new pond.

Decanted Water Discharged from Under Tailings Dam

Sands from the hydroseparator flow 40,000 ft through a 16-in. pipe

line which, at its lower end, is placed on top of the outside gravel dike. Spigots in this pipe line discharge the sands into the area between the outer dike and the slime dike. Slimes entrained in these sands flow across to the slime dike and along it to a low dividing dike where they are collected and pumped over the slime dike into the slime settling area. Towers within this area decant clear water, which is carried under the dikes in 30-in. concrete pipes and is eventually discharged into the Clark Fork River.

Control of dusting from the tailings and protection of the dam against break-outs is absolutely essential because of the presence of two State hospitals, two transcontinental railroads, cultivated land, and populated regions downstream from the area.



A 48-inch pipe feeds tailings into the hydroseparator, where slimes are scalped off and overflow is fed into a 370-ft thickener. Clear water overflow from the thickener is returned to the mill for reuse. No. 2 tailings pond can be seen beyond the thickener

Precipitating Plant Effluent Neutralized with Residual Lime

At Butte, drainage water from the mines is pumped to the surface and collected at a central location for the removal of dissolved copper salts by precipitation on tin cans. The effluent from this precipitating plant contains a high concentration of iron salts, which, if discharged into a natural drainage system, would pollute the stream and make it unsuitable for agricultural or recreational use, and definitely unpotable.

The flow out of the precipitating plant amounts to 3000 to 5000 gpm, has a pH of from 3.5 to 4.0, and contains about 2.5 grams per liter of iron, mostly as ferrous sulphate.

This effluent is discharged into Silver Bow Creek, down which it flows to a diversion dam six miles from the Anaconda plant. At this point the major part of the normal flow is diverted into Silver Bow Ditch, leading into the head end of the principal tailings disposal area. Any flow above the capacity of this ditch continues on down Silver Bow Creek where it is later joined by all of the effluent from the Anaconda tailings ponds.

Treatment of Silver Bow Creek water consists of neutralizing it with the high lime content of the concentrator tailings and precipitating the dissolved ferrous sulphate as ferric hydroxide.

The first step in the neutralization of the Silver Bow Ditch water is to pass it through the old tailings ponds where it comes in contact with the residual lime in the tailings. The water is dispersed over the old ponds where it not only contacts the residual lime, but is also helpful in the control of dusting from these areas. It is later collected and channeled back into Silver Bow Creek downstream from the tailings disposal area.

Recording pH Meter Checks Stream Alkalinity

The clear water outflow from the decant towers in the new tailings disposal area has a pH of about 11.0 and it, too, joins Silver Bow Creek below the tailings area. The reaction of the lime in this water with the acidic Butte water adjusts the pH of the total stream to about 7.0 pH, thus completing neutralization.

An exceptionally high outflow from the Butte Precipitating Plant, or cold weather, which slows down chemical reactions, sometimes upsets the balance between the two waters, leaving the stream with too low a pH. On these occasions it is necessary to add lime to maintain proper alkalinity. This is done by flowing a measured amount of milk of lime from the concentrator supply tank, down a ditch directly into Silver Bow Creek.

A recording pH meter on the stream, after all of the constitutents have been united, indicates when these lime additions are necessary, and how much lime must be added.

When the alkaline Anaconda water is mixed with the acidic Butte water, the ferrous sulphate from the precipitating plant is converted to ferrous hydroxide. Further flow down the turbulent stream oxidizes the ferrous hydroxide to ferric hydroxide, a precipitate which will settle rapidly under proper conditions.

These conditions are furnished by the River Pond, a 400-acre settling basin formed by a gravel dam built across the valley of Silver Bow Creek, near Warm Springs.

The combined Butte and Anaconda waters, bright red with ferric hydroxide at this point, empty into the head end of the river pond. The precipitate settles as the waters work through the pond, and in doing so carries down with it any other solids suspended in the stream.

The water overflowing the decant towers located near the river pond dam is perfectly clear, has a pH varying between 6.8 and 7.4, and is entirely suitable for discharge into the Clark Fork River.

In the disposal of metallurgical wastes, the best methods are those which deposit the materials in a safe storage location, at minimum cost to the operation, and with minimum nuisance to the people working and living in the area. It is felt that at Anaconda these conditions have been met.

Inclined Drilling and Blasting

New technique holds promise of improved blasting efficiency at open pit and strip mines

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Department of Mining
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THE purpose of this article is to show that angle drilling is a new and a better blasting method than others now used in the industry. It can be said that angle drilling is an old method, because in underground, in construction, and even in surface mining, this method has already been applied using small drills. However, it can also be said that it is a new method, because nowadays, practically only vertical or horizontal holes or a combination of both are in use in domestic surface mining.

When only a small drill was available and borehole diameter and hole length were limited, horizontal and vertical boreholes or a combination of both were used as is shown in figure 1. So long as a horizontal hole or tunnel loaded with explosive is able to break down a high vertical face and to produce good fragmentation, the horizontal hole or tunnel blast is the cheapest method. However, in horizontal thick rock strata, this is not possible. Therefore, vertical or a combination of vertical and horizontal holes is more economical. Through research carried out before World War II, it was discovered that the highest powder factor (15 to 23 tons per lb) can be obtained with inclined boreholes. Therefore, the method J in figure 1 has been developed.

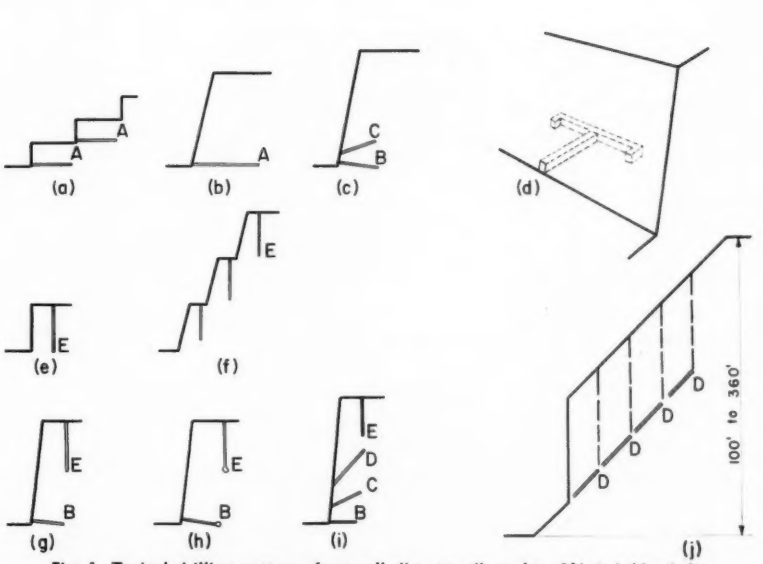


Fig. 1. Typical drilling patterns for small diameter (less than 3½ in.) blastholes

At the present time, when machinery to drill long holes of large diameter is available, the situation is practically the same. So long as the horizontal hole, due to rock structure, is capable of breaking the vertical bench face down and obtaining good fragmentation, this is the cheapest way (figure 2). In coal stripping this case is especially favorable, because the rock layers directly over the coal are soft. Therefore, the drilling of horizontal holes is usually much cheaper than vertical holes. Otherwise, a vertical hole must be selected.

The first large hole drilling machine which conquered the market was the churn drill. Because this drill is able to drill vertical holes only, it was logical to use vertical drilling. A great number of percussive drills, up to a four-in. hole diam, have been working in the industry for many years. However, although it is easy to tilt this machine and to drill inclined holes, practically nobody thought about this possibility. People have not been aware of the advantages they would obtain with angle holes using their own machine.

Angle Drilling Provides More Effective Blast Holes

To determine the thickness of walls or pillars when building a house or bridge, two factors must be known:

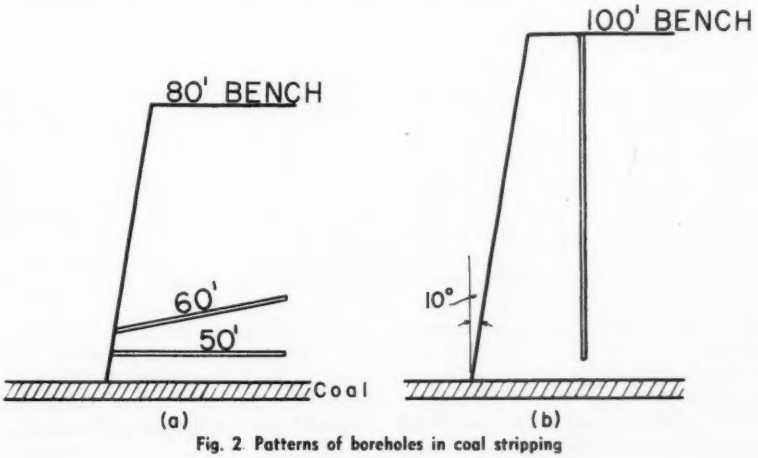


Fig. 2. Patterns of boreholes in coal stripping

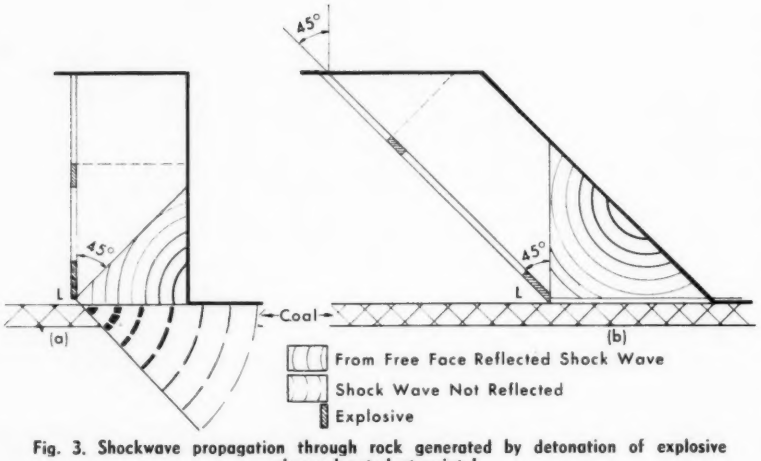


Fig. 3. Shockwave propagation through rock generated by detonation of explosive charge located at point L

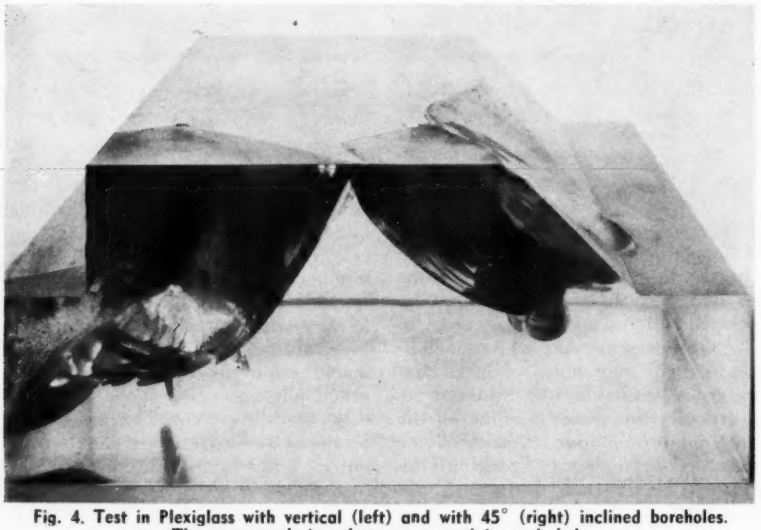


Fig. 4. Test in Plexiglass with vertical (left) and with 45° (right) inclined boreholes. The same explosive charge was used in each hole

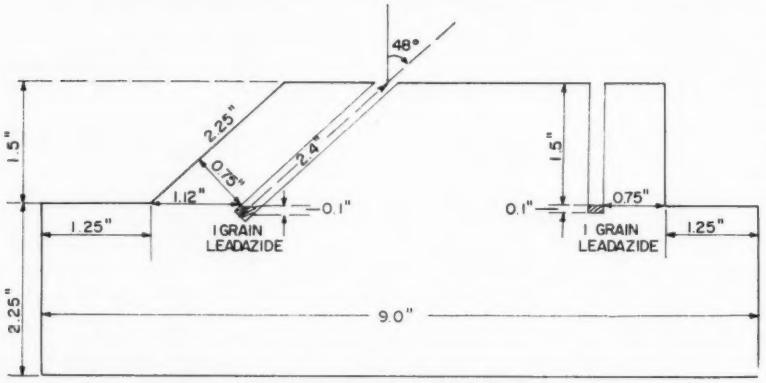


Fig. 5. Cross section through boreholes in Plexiglass

the loading force and the resistance force.

The weight of the roof or structure located above the area in the wall or in the pillar which must be calculated represents the loading force. Strength characteristics of material determine the resistance forces. Knowing the loading and resistance forces and selecting a desirable safety factor, the thickness of the wall or pillar can be determined.

It will aid in understanding the blasting phenomena to distinguish between two forces called an explosive force and rock resistance force against blasting. Blasting force depends upon the type of explosive and technique applied. Rock resistance against blasting depends upon strength characteristics and structure of rock. Because the tremendous force acts extremely fast, the failure phenomena through blasting is, of course, very complicated. There are two loading forces; one almost instantaneous, highly dynamic force which generates a shock wave. This shock wave propagates through rock, hits the free face, reflects, runs back pulling material out, breaking it from outside to inside. Also, on the way to the free face, fracture in rock can be formed by a shock wave.

The described phenomena are finished before the rock located in front of the explosive charge starts to move. Thus, the explosive gases enclosed in the borehole might have time to exercise a pressure upon the borehole walls. This static force can also break the rock. The type of rock and explosive determine which of both forces is more responsible for rock failure.

Rock fracture occurs by reflected shock waves when a high explosive is detonated in compact rocks. The greater the angle of inclination of bench face (figure 4), the larger will be the free face area and the more energy reflected from the free face; therefore, the greater rate of explosive energy is available for fragmentation. Comparing vertical with 45° inclined hole, twice as much shock wave energy generated in point L (figure 4) will be reflected. Because the main problem consists of breaking the toe of the bench, with explosive located at the bottom of the hole, the statement is correct. This can be demonstrated by looking at the Plexiglass in figure 4 where a vertical and 45° inclined borehole have been blasted. Burden, bench height, borehole diameter, type and amount of explosive and subdrill depths have been kept the same (figure 5).

However, the force distribution and fracturing are quite different. In a vertical borehole, much more explosive energy went underneath the quarry level (figure 3, 4). It is not only that a great amount of explosive force is lost, but also that its action causes an undesirable effect (figure 4). Either it breaks coal in coal stripping, or fractures the rock in quarries, in such a fashion that it is difficult to drill through it later on,

when this part of the rock must be blasted. The loss of explosive force, as well as resistance of material at the toe, is so great on the vertical bench that the Plexiglass remained unbroken. The inclined hole shows just the opposite result. Until now, about 150 blast tests in Plexiglass have been completed. The experience gained in large scale blasts confirms these conclusions.

Laboratory Tests Confirm Theory

When digging the earth with a shovel in the garden the shovel is inclined 45°. The difference in earth resistance would be noted at once if the shovel were held vertically instead of inclined.

From figure 6 it may be seen that it is more difficult to break the toe of equal burden with an explosive charge located at point L when the face is inclined counter-clockwise, and easier when it is inclined clockwise. The rock resistance against blasting depends upon the angle between bench face and quarry level.

It is known that much less explosive per unit of volume is needed to break a boulder than to blast rock from a bench (figure 7). Also, the nearer the explosive is moved along the borehole to the toe of the bench, more pounds of explosive are required to blast a ton of rock. Excepting for slight amounts, the amount of explosive charge is inversely proportional to the number of free faces (figure 8). Powder factor figures indicated here as well as in figure 7 are for limestone and for small borehole diameter. Going along the borehole from the top of the bottom in case (a) the powder factor at a vertical bench decreases from 18 to 4.5 tons per lb (or to 3.0 tons per lb in a subdrilled area). In case (b) the point three would no longer be at the bottom of the bench, therefore, instead of 4.5 about nine tons per lb explosive can be blasted. The point three in case (c) will require a powder factor which would be some place between powder factors in cases (a) and (b), namely, between 4.5 and 9 tons per lb, probably around six tons per lb. In case (b), the powder factor at the bottom of the bench is slightly higher because of difference in weight of rock on a higher face. It is also slightly higher in point three in case the borehole would end in point three.

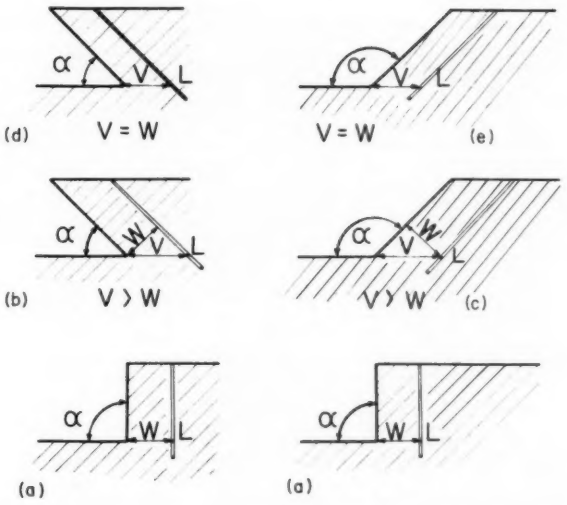
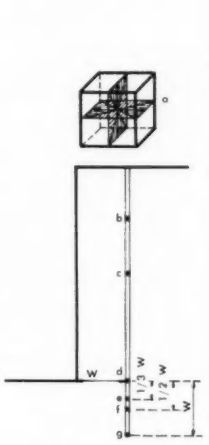


Fig. 6. Rock resistance against blasting versus bench inclination



No.	NUMBER OF FREE FACES n	LOADING FACTOR INDEX 1/n	POWDER FACTOR IN LIMESTONE gm/t	t/lb	cy/lb
a	6	0.17	8	56	
b	2	0.5	25	18	10.7
c	1	1	50	9	5.2
d	0.5	2	100	4.5	2.6
e	0.35	2.9	150	3.0	1.7
f	0.25	4	200	2.3	1.3
g	0	∞	∞	0	0

Fig. 7. Loading factor (L.F.) and powder factor (P.F.) as a function of the number of free faces

It is known that the law governing the rock failure in small and large scale blasts may differ. It is also known that it is difficult to simulate in the laboratory, the natural conditions in the quarry or stripping operations. However, on large scale blasts, it is difficult to keep the factors affecting blasting results under strict control. Therefore consider the experience gained through small and large scale blast tests and note how it confirms the theory.

It has been stated that compared with a vertical hole, twice the explosive energy is available for fragmentation from explosive charge detonated at the bottom in a 45° inclined hole (figure 3). This has been demonstrated through blast tests in Plexiglass (figure 4). It can be seen that a great amount of explosive energy is trapped underneath

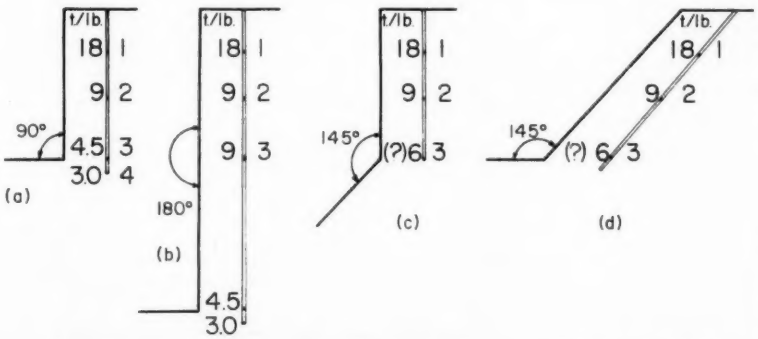


Fig. 8. Powder factor as a function of the explosive charge location along the borehole and inclination of bench face

Table 1. Test Results in Plexiglass Blasted with Lead Azide

Blast No.	Bench Height	Angle to Vertical	Hole Length	Sub-drill Depth	Burden	Distance from 3rd Free Face	Explosive Charge (lead azide)		Blasted Vol.	Blasted Weight	Powder Factor[1] Kg. plexiglass / gm. explosive	Loading Factor[2] A gm.expl. / Kg. plex.	Loading Factor[2] B gm.expl. / sq. cm.
	in.	°	in.	in.	in.	in.	grain	gm.	cu.cm.	gm.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 a	1.5	45	2.5	0.3	0.75	2.25	1.08	0.07	77.3	86.7	1.24	2.3	6.8
1 b	1.5	....	1.8	0.3	0.75	2.25	1.08	0.07	.....	.....	.....	4.6	9.7
2 a	1.5	48	2.4	0.1	0.75	2.25	1.00	0.065	80.7	90.3	1.39	1.9	6.0
2 b	1.5	....	1.6	0.1	0.75	2.25	1.00	0.065	.....	.....	.....	4.2	9.0
3 a	1.5	48	2.4	0.1	0.75	3.00	1.50	0.097	84.1	94.2	0.97	2.8	6.0
3 b	1.5	....	1.6	0.1	0.75	3.00	1.00	0.065	.....	.....	.....	4.2	9.0
4 a	1.0	48	1.6	0.1	0.75	3.75	1.00	0.065	31.6	35.3	0.54	2.8	9.0

[1] Powder Factor in column 12 is calculated by dividing the blasted weight of plexiglass (column11) by the explosive charge (column 9).
[2] A – Loading Factor calculated for a single borehole blast assuming that the breakage angle on this hole projected horizontally is 90°.
B – Loading Factor calculated by dividing the explosive charge by the blast hole cross section taken perpendicular to the bench.

the quarry level and wasted. For this reason, and because of increased resistance in the material, it is difficult to break the toe of a bench with a vertical hole, but it is easy with an inclined hole. For the same reasons, an angle hole requires smaller subdrill depth than a vertical hole. In all blast tests the subdrill depth was only 13 percent of the burden (figure 5) and all angle holes broke the toe perfectly (figure 4). In quarries the subdrill depth is usually 25 to 33 percent of the burden.

Beside eliminating the toe problem and improving fragmentation when using angle drilling, explosive and drilling costs may also be reduced.

In table 1, data from blasting tests in Plexiglass (figure 4, 5) are summarized. From these data, it can be seen that the weight of the Plexiglass blasted consistently is affected by the angle of borehole to the vertical, by the distance from the third free face to the borehole, and by the weight of explosive charge.

From this table it can be seen that only half the amount of explosive per Plexiglass volume unit has been used in 45° inclined holes. The angle holes broke the Plexiglass perfectly, the vertical hole did not.

To determine how much less explosive is required for an increased angle of bench inclination, blast tests have been carried out. The diagram in figure 9 shows clearly the correlation between angle of inclination and burden. For the tested location of explosive, the burden of 30° inclined hole can be increased 50 percent compared to the burden of vertical hole. However, other locations of explosive along the borehole must be examined before this question can be answered. Formerly it was indicated that one percent explosive could be saved per each degree of inclination. It is best to be conservative and use this statement until new evidence is discovered by future research on small and large scale blasts.

Laboratory tests have shown that the outbreak angle in material is larger with an angle hole, therefore greater spacing can be used than with vertical holes.

Figure 10 shows that less drill footage is required for angle holes than for vertical boreholes. Each foot of hole above the quarry level breaks equal quantity of rock assuming the burden in both cases is the same. However, greater spacing and less subdrilling can be used with an angle hole. Therefore, larger rock volume can be blasted per foot of borehole using inclined drilling.

The blast tests in Plexiglass demonstrated that much larger throw distance can be obtained with an inclined borehole. The throw distance obtained in a 1.5 in. bench with 0.47

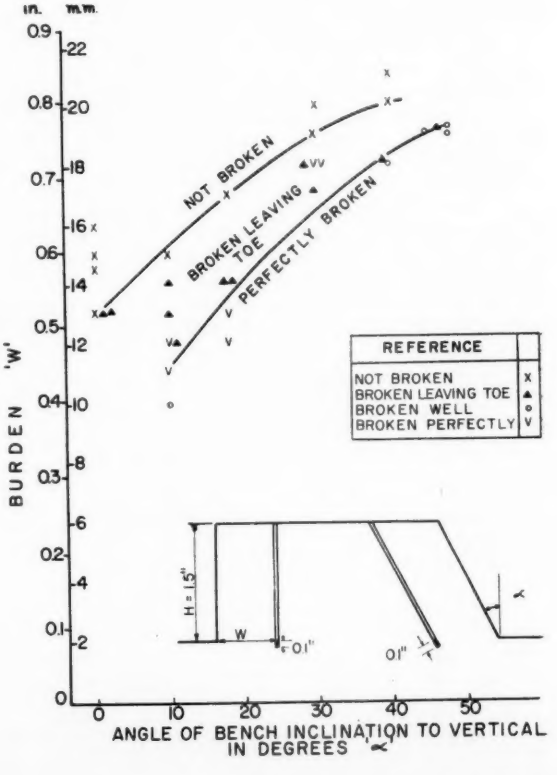


Fig. 9. Burden versus angle of bench inclination

in. burden was 11 to 12 ft for vertical and 33 to 35 ft for 45° inclined boreholes. In 0.63 in. burden the throw distance obtained with a vertical hole was none, with a 45° inclined hole it was seven ft. These results are of importance for casting rock with explosive in stripping operations or in road construction.

Field Tests Demonstrate the Value of Inclined Drilling

The operators of quarries and open pits where inclined drilling has been adopted affirm that the toe problem and back breakage have been eliminated, much better fragmentation obtained, and safety increased.

In a basalt quarry of the Rock Hill plant belonging to the General Crushed Stone Co., 20° from vertical inclined borehole drilling has been gradually introduced in a 40-ft bench since January 1959. Taking the total explosive consumption and tonnage produced, from year to year, the powder factor has been improved from 2.97 tons per lb explosive in 1958 to 3.66 tons per lb in 1960. In the same time the precentage of ammonium nitrate used increased from 30.1 to 39.5 percent. The product from burden times spacing has been increased from $18 \times 18 = 324$ sq ft to $18 \times 20 = 360$ sq ft. Therefore, the drilling cost has been reduced $0.99 per ton. The blast effect of the last four blasts was such that it is planned to use 19 ft burden and 21 ft spacing in the future. Thus, further saving in cost for explosive and drilling are expected.

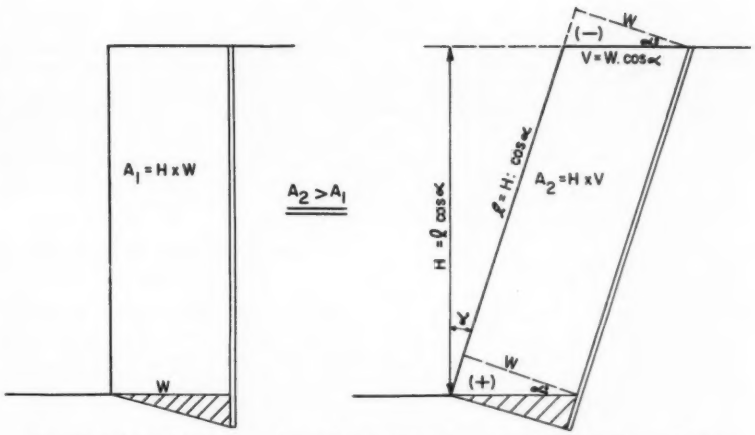


Fig. 10. Relationship between bench face inclination and length of borehole and tonnage blasted

This quarry has a second bench 180 ft high. It was abandoned years ago because of toe problems and now angle drilling is being adopted on this high bench.

Because it is difficult to keep the bench face strictly vertical in stripping operations, and the drill must be placed a safe distance from the edge of the bench, a vertical hole on a high bench results in too great a burden for the given borehole diameter (figure 11). Out of this consideration, and because it is easier to start and to end stripping operations and to adapt to different topographic conditions when using inclined holes, the management of Hanna Coal Co. put into operation a drill especially designed to drill nine-in. inclined boreholes.

As has already been shown, an angle hole of two in. diam is capable of blasting 15 to 23 tons per lb (figure 1j). In another limestone quarry an angle hole of 3¾ in. diam blasts 10 to 16 tons per lb of explosive. Ten to 20° from vertical inclined holes of four in. diam drilled down to quarry level blast in limestone, dolomite, and asbestos seven to nine tons per lb, whereas, the powder factor in quarries obtained

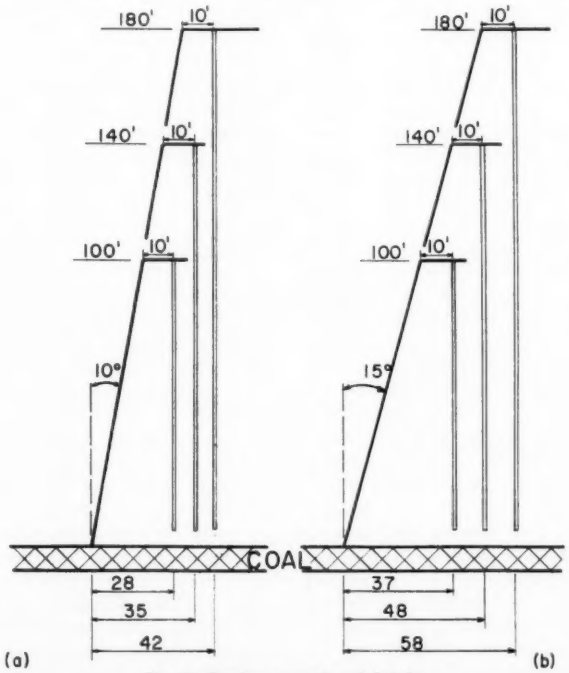
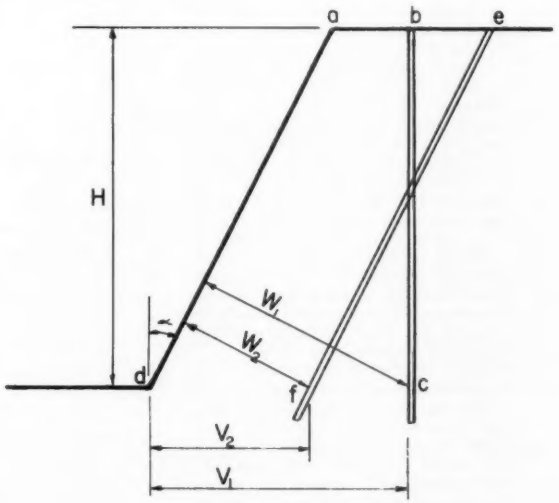


Fig. 11. Burden versus bench height



AREA abcd = AREA aefd

$[(V_1 - V_2) : V_1] . 100 = 62\%$ for $\alpha = 30°$

or $[(W_1 - W_2) : W_1] . 100 = 62\%$ for $\alpha = 30°$

Fig. 12. Burden decrease through angle drilling

with vertical holes is 2.5 to 5 tons per lb only. Boreholes diameter, and therefore the size of burden, play a great role in the powder factor. The powder factor in quarries is calculated, and rock is broken in such a way, that rock pieces can be easily loaded by a two to eight cu yd shovel and pass through the crusher. Large throw distance is preferred to assure better fragmentation and to keep the rock pile low. Therefore, it cannot be compared with a powder factor obtained in coal stripping operations, which is naturally higher.

This year a modified angle drill method has been tried in stripping operations. Eighteen percent saving on explosive, as an average, and 27 percent as a maximum have been obtained. For this operation the saving on explosives is about $2000 per month.

Many companies have decided to introduce angle drilling. One year from now much more information on the matter will be available.

Benefits Enjoyed from the Use of the Inclined Drilling Method

1. **Safer operation for men and shovels.**
2. **Higher benches may be blasted and number of haulage levels reduced.**
3. **Toe and back breakage can be eliminated.**
4. **Better fragmentation will occur:**
   a. Because of better utilization energy (figures 3, 4) and reduced rock resistance against blasting at the bottom of the bench (figure 6).
   b. Because of the reduced rock volume around the stemmed part of the borehole at the top of the bench, where there are usually large boulders (figure 3).
5. **Cheaper blasting operations will be obtained, because less footage on drill and/or less explosive per ton rock are required. Smaller borehole diam can be used. Because a length of borehole used for stemming and for subdrilling is a constant for a given burden, and the inclined hole is longer than a vertical one in a given bench height, more explosive can be loaded in an inclined borehole (figure 3). Thus, a higher utilization of borehole is possible.**
6. **Higher efficiency and cost reduction in loading haulage, and crushing operations through better fragmentation (figure 3).**
7. **The damage to coal by blasting the waste rock in coal stripping operations will be much smaller or even altogether absent (figure 4).**
8. **It is easier to drill the lower bench, because the damage to rock around the subdrilled area is smaller (figure 4).**
9. **Damaging effect of vibrations in the surrounding area is decreased.**
10. **The throw distance will be greater.**
11. **In the same bench height, the angle hole is longer. Therefore, larger tonnage can be blasted per foot of bench face length with the same burden.**
12. **The use of a machine capable of drilling holes at various angles makes it easier to start an initial cut, create a new face in different topographic conditions, and complete a final cut.**

Field Application of Inclined Drilling

Inclined drilling in general can be used under all conditions encountered in surface mining. Structure of rock may have some effect on its use.

The lower the bench, the smaller is the powder factor. The inclined hole method could improve the powder factor and/or decrease the drill footage. In quarries where a toe problem exists and fragmentation is poor, or where the rock structure causes undesirable back breakage, the inclined hole might eliminate all of these problems.

On a high bench, particularly, it is the best solution.

Vertical boreholes often produce excessive back break which can be caused by the structure of rock or by too heavy a burden in relation to the bench height. Besides, the upper edge of a bench usually breaks easily or is removed by shovel. For safety's sake, the operator must place the drilling machine far enough back from the upper edge of the bench to avoid having the drill fall into the pit. For these reasons, the higher the bench, the greater the distance from the foot of the bench to a vertical borehole—in other words, the greater the amount of burden (figure 11). Reaching a certain height, the borehole diameter of an available drilling machine might not be large enough to place sufficient explosive in the borehole to break the burden without leaving a toe. An easy solution to the problem is to drill inclined holes. It will not only solve the toe problem, but will permit blasting of the same amount of rock with smaller burden which means a smaller amount of explosive (figure 12).

Prevention of coal damage (figure 3, 4) or safety problems on high faces could be other reasons for adaptation of angle holes.

Several companies are showing interest in inclined drilling because it reduces blasting vibrations.

The inclined borehole method is the best one for casting overburden with explosives in stripping or rock in road construction because the inclined hole throws the rock much farther away than other types of borehole.

In combination with the presplitting technique, angle holes can be very useful in construction and in the mining industry.

The Future Calls for "More Research"

There is sufficient evidence at the present time to indicate that inclined drilling will spread rapidly throughout the industry. Several years of costly research work has been required to reach this stage, but the work is still unfinished.

The Pennsylvania State University is indebted to the following for their aid in this work: DuPont de Nemours Co., General Crushed Stone Co., Hercules Powder Co., Joy Manufacturing Co., National Lead Co., Peabody Coal Co., and Rheinische Kalksteinewerke Co.

People in all of these companies have been helpful in supporting the research but, because of their early and continued support since 1953, the author would like to cite, in particular, the names of W. L. Wearley, president of Joy Manufacturing Co., and P. Flachsenberg, president of Rheinische Kalksteinewerke Co. The author is also indebted to W. Julian Parton, president, General Crushed Stone Co., for permission to use his quarries for large scale test blasts.

It is certain that the mining industry can be proud of its accomplishment, however, continued progress is essential. The current explosive costs of about one cent per cu yd of rock removed with large stripping equipment is certainly a wonderful achievement. However, efficiency of utilization of explosive shockwave energy in missiles is about 100 percent, in blasting rock, only 5 to 10 percent. Can the industry be satisfied with this? A borehole is like a screen with big holes, through which explosive energy escapes. The idea of the angle hole method allows us to utilize the explosive energy that is now escaping.

There are many other means of combating this waste. Consequently, more research is required. Money obtained will be used for developing of technique which would allow the reduction of blasting costs, for the education of new engineers, and for the improvement of university research facilities. Recommendation for the future, therefore, can be put into two words—"More Research".

Wire Rope Spooling—Method and Practices

Factors that must be considered in achieving proper wire rope spooling

By LONNIE THOMPSON
Chief Sales & Service Engineer
LeBus International Engineers, Inc.

A hoist is a machine designed to do work by the medium of wire rope. Consequently, whenever wire rope is not being spooled smoothly and efficiently, the machine is not doing its best work and the hoisting operation is not as economical as it could be.

The Need for Proper Spooling

In the past few years equipment costs and operating expenses have risen tremendously while market prices for most products have advanced more slowly. Therefore, most companies are working closer than ever to a profit-loss margin. Expendable items demand attention and wire rope is an expendable item.

A good spooling operation is one that operates trouble-free and allows full speed. It is one without excess whip in the rope due to spooling and with a minimum amount of scrubbing and cutting in of the rope. If this can be obtained, then maximum service can be derived from the rope. Thus arises the need for proper wire rope spooling.

Three Basic Methods in Use

There are three basic patterns of spooling wire rope in use today: Helical spooling, single crossover parallel spooling, and double or two crossover parallel spooling (figure 1).

Helical Spooling. This is the system where the initial layer of rope progresses across the drum in a helical pattern like a thread on a bolt; thus, its name. It is the oldest system in use and is the best for spooling one layer of rope. It is not satisfactory for multi-layer spooling due to having to spool against the helix on the second layer. On the third layer the spooling pattern is lost. Spooling back across a helix on the second layer forms two crossovers which occur in about one-third the circumference of the drum. This creates undue scrubbing on the rope in the crossover area and also induces vibration of the rope spooling either on or off the drum at fast speeds. Kickers and riser strips are difficult to locate properly on the drum due to the ever-changing crossover area.

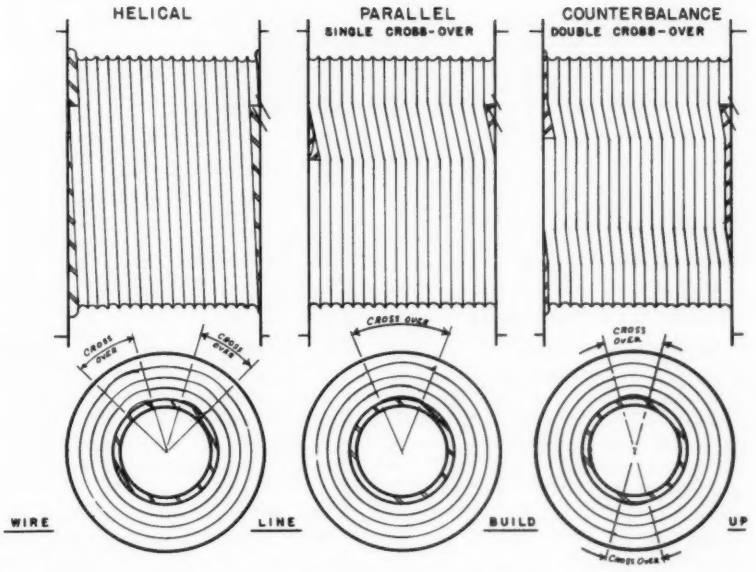


Fig. 1. Helical spooling, single cross-over parallel spooling and double cross-over spooling are the three basic wire-rope spooling patterns in use today

Single Crossover Parallel Spooling. In parallel type or single crossover spooling, the rope spools parallel to the drum flanges and crosses over one diameter where the rope enters the drum. This system can be used for multi-layer spooling. However, it has the disadvantage that all the build-up of rope is on one side of the drum due to rope crossover at one point on the drum. It also crosses the rope over in a short space and must move the rope one diameter each crossover. There is a tendency to vibrate to excess when spooling on or off the drum at high speeds and the wire becomes unbalanced due to the single crossover and rope build-up on one side of the drum. The rope also crosses over two diameter wire ropes to advance one pitch, subjecting the rope to flattening and wear in the crossover area.

Double or Two Crossover Parallel Method. The two crossover system—double break or counterbalance type also employs the use of parallel spooling but with two parallel sections offset one-half pitch and two crossover sections located 180° apart, each crossover moving only one-half line diameter from its spooling path.

It is ideal for multi-layer spooling because the build-up area is now divided 180° on the drum due to the crossover. The build-up is less severe because each crossover has only to cross the top of one layer of rope. This reduces wear somewhat at the crossover points and allows faster spooling with less line whip.

This method is a new development but has been proven best for all types of multi-layer spooling in almost every type of hoisting application. Due to the reduction of movement of rope from its spooling path, it lends itself more readily to high-speed spooling than any other method for multi-layer winding. With the crossover controlled in its own area while spooling, it is possible to use the correct riser and kick-over strips to control its spooling every layer. It has been used in spooling as much as 30,000 ft of line in 37 layers working to one-half the breaking strength of the wire rope.

Plain Drums Versus Grooved Drums

Plain Drum Spooling. With bare drum spooling (often referred to as hand spooling because the rope is spooled on the initial layer by hand), the initial layer forms the pattern by which all the wire rope will be spooled on the drum. To do this, one must spool the rope tight and evenly on the plain drum. The diameter of the wire rope must be such as to come out even between the flanges, and if so it will then spool in a parallel pattern. This can be expected to spool so long as the initial layer remains fixed and the diameter of the rope spooling the upper layers is not larger or too much smaller than that on the bottom layer. With the single crossover, rope builds up on one side of the drum.

If a helical end filler has been mounted on a plain drum, the pattern of spooling will be helical. This is not recommended on a plain drum because it is necessary to fill the drum with one complete layer of rope before hoisting and consequently there is the problem of spooling rope against the helix on the second layer and upper layers. Wire rope scrubbing and cutting in is also too excessive to give any reasonable service for practical use.

Another disadvantage to plain drum spooling is the lack of grooves to support the rope strands. The rope is often flattened and damaged severely on the bottom layer due to this.

Grooved Drum Spooling. The functions of a grooved drum are these:

First, it sets the pattern by which the rope is to be spooled: there are three methods; helical, parallel and double crossover.

Second, it sets the pitch for all the wire rope to be spooled upon.

Third, it supports the initial layer of rope in a groove deep enough to give support to one complete strand so as to prevent crushing and flattening of the wire rope, a feature not to be overlooked.

Selecting the Method of Grooving

Now, the first job is to select the type of spooling that is needed. If one layer is to be spooled and one only, the helical method will serve well.

For multi-layer spooling, two to thirty layers, the two crossover method is best. This is due to the fact that a better balancing condition of wire rope on the drum can be achieved. There is also less movement of the line from its spooling path. One important feature that has not been mentioned is that it spools the same number of wraps on each layer. On some spooling applications, this is very important because it makes possible the use of double-threaded lead screw attachments for fleet angle correction since the attachment can be geared in direct ratio to remain in constant timing on all layers.

The pattern of spooling is all important, because it must be such as to repeat itself on each layer in order to obtain smooth performance. The double crossover method obtains this pattern better than the other two systems.

Grooved Drum Limited to One Rope Size

Selection of the proper pitch of the groove depends upon many factors, some of which are noted in the box below.

These are all factors that are used to determine the correct pitch of the groove. In some fields, groove standards have already been adopted; to the user this means that maximum service can be obtained for a given size rope when good hoisting procedures are used.

Another feature concerning the pitch of grooved drums that is not common knowledge is that different spooling applications require different pitches in order to obtain the best service from the wire rope. Many times it is possible to make the pitch small for the line in order to allow more working variation for the line. The drilling rig is such an example. On a slow-moving industrial hoist operating at much lighter loads, a pitch to the full size of the rope is necessary.

To get the full benefit from a grooved drum, the grooves must be deep enough to support the rope on the initial layer. To do this, one-third of the line circumference must be supported in the groove.

The grooved drum has the advantage of eliminating the need to hand spool, thus greatly reducing the hazard of getting caught in the wire rope while spooling onto the drum. It sets a better spooling pattern, and it is a means by which the line can be turned around and spooled to get the service from the drum end of the line for some applications. Due to the improved spooling pattern, the hoisting operation can be conducted at the fastest possible speed. Longer line service can also be expected due to better spooling at the drum at all times. The only disadvantage comes from the fact that a groove can be used for only one rope size.

Importance of Proper Fleet Angle and Line Tension

There are only two factors that can prevent good spooling with methods in use today—improper fleet angle and lack of proper line tension.

The fleet angle (figure 2) is the angle the rope makes with the flange from the head sheave of the fixed fair lead. The result of improper fleet

1. Amount Of Line To Be Spooled
2. Size & Width Of Drum
3. Tension On Line
4. Pick-up Position of Load
5. Type Hoisting Job
6. Hoisting Speed

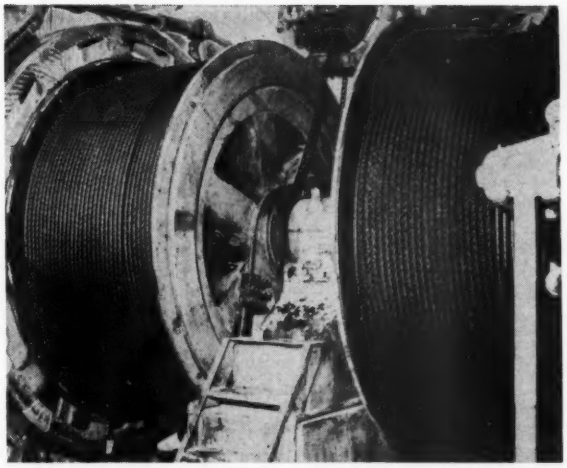
No. Layers	Light Loads		Heavy Loads	
	Narrow Drums	Wide Drums	Narrow Drums	Wide Drums
2–10	Full API	Avg. Line Size	Full API	½ API
8–30	Full API	Avg. Line Size	Avg. Line Size	½ API
1	Use Helical Grooving Full API + Clearance			

Depth of Groove—120° of Line in Groove
Radius of Groove—API Sheave Gauge
Angle of Cross-over—3 to 5°

angle is improper spooling, time loss and less wire rope service. The breaking away of the wire rope from the flanges causes voids and gaps which are a familiar sight to most operators. Failure to spool against the flanges is a sure sign of a bad fleet angle.

The correct fleet angle for spooling is not an accident—it is planned and engineered into the unit. The best working fleet angle is ¼° to 1¼°. However, line can be expected to spool up to angles of 1½°; beyond that, trouble will occur.

Now, it is a fact that not every hoisting situation will permit a desirable working angle. In such cases, devices are used to correct the angle; the larger the unit and heavier the load, the more costly is the correction device.



A 72 in. diam double-drum hoist equipped with LeBus grooving spools 4500 ft of 1⅛-in. wire rope in four layers at a copper mine in the Southwest

Devices in use are geared, double-threaded lead screw assemblies which are powered by the rotation of the drum. Aside from the cost to build and install such devices, they have often failed to work properly due to the method of spooling previously used. The failure is due to the fact that helical or parallel (single crossover) spooling does not put the same number of wraps of rope on each layer; thus, the device, when spooling multi-layers, gets out of time with the reeving in or paying out of the rope. However, with the two crossover system, it can be geared to function properly because each layer has the same number of wraps of rope.

In recent years there have been other type correctors put into service which are actuated by the movement of the wire rope itself. No gearing to the drum is required and mounting of these correctors is simple. They are more economical and for most applications will serve as well as any.

Due to these improvements it is no longer necessary to tolerate any hoisting application wtih poor winding due to excessive fleet angle conditions. Aside from better winding on the drum which increases rope service, these devices offer a safer hoisting operation. Safety is the most important contribution of this equipment to wire rope spooling.

No spooling job can be accomplished regardless of the equipment unless there exists enough pull on the line to spool it tight on the drum. The amount of tension required depends upon the size of the rope, diameter of the drum, and the speed of operation. The smaller the rope, the less tension is required. The faster the hoisting speed, and the smaller the drum diameter, the greater the tension required. The speed of operation is a big factor, especially where the angle of spooling exceeds 1°, because if the line tension is small, operating at fast speeds causes the rope to break away from the flange.

There are many practical devices used to correct line tensions when needed. Some applications use a large rubber roller applied at the drum to keep the rope positioned correctly. This is most successful with grooved drums using a parallel type spooling because it will hold the line in the groove at all times. Tensioning sheaves operated manually, by air or hydraulically can be used at the fair lead or fast sheave, depending upon the spooling setup. Spring-loaded rope tensioning devices are used in the crane hoist field on some wire ropes. Almost every application has its own type of installation due to po-

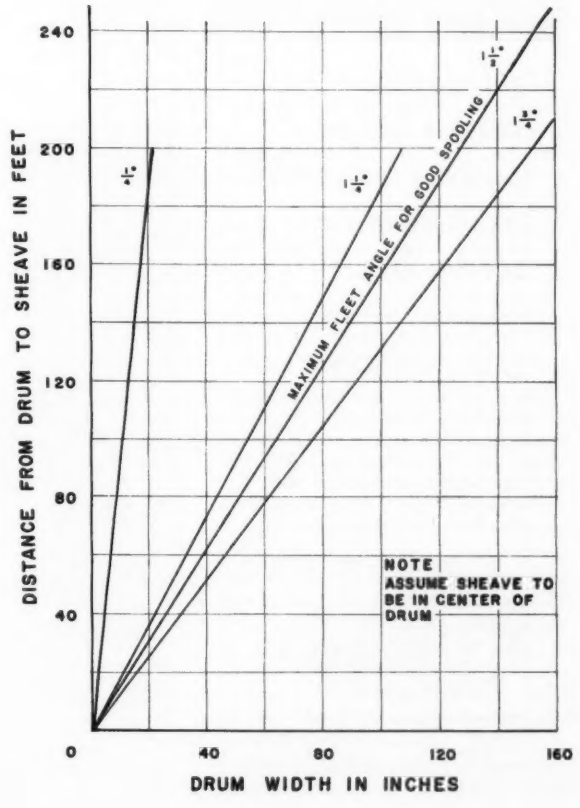


Fig. 2. Fleet angle chart gives fleet angle limits for various drum dimensions and drum to sheave distances

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sitioning, space, etc. It is safe to say that it is almost impossible to get too much wire rope tension for most hoisting jobs and like every other phase of spooling, it affects the service life of the rope.

Obtaining the Correct Wire Rope

A vast amount of machinery requires the use of wire as a functional part of its operation—it is the medium for performing many of the complicated tasks being done today. Like other industries, the wire rope manufacturers are doing their part in keeping pace with improved equipment and methods. Like most of us, they maintain a large service organization to help with functional problems of application. Their services are invaluable in many hoisting applications in setting up proper methods and procedures for use and care of the wire line. If there is a special or out-of-the-ordinary hoisting job, they can recommend the correct rope and handling procedures for it.

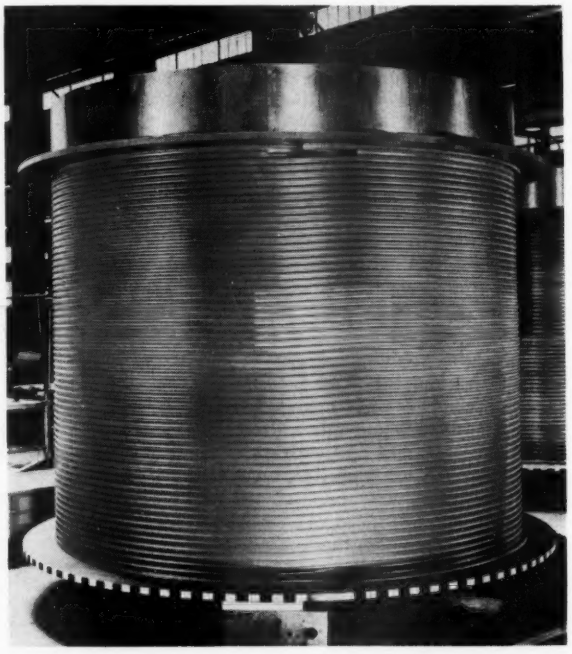
The tolerance of a new wire rope is important to the user. For any given size, a maximum and a minimum tolerance has been set up. A rope that is undersize is always undersize and will reach throw away point sooner than those up to standard. An oversize rope is subjected to excess scrubbing and wear in sheaves and if a grooved drum is used, may not spool properly before being damaged at some critical point. The operator should know and insist on a wire rope that meets standard federal specifications.

The recommendation of the proper wire rope for the hoisting job is a service performed by a wire rope service engineer. He will also suggest the proper handling and working procedure.

For units spooling on a plain drum, rod and tubing drums for instance, a good rule of thumb is to select a right lay rope for lefthand spooling and a left lay rope for right-hand spooling.

Of all the things that can be said about the use and service of a wire rope for any job application, the most important thing is the proper instruction of the crew for its use and the enforcement of a good inspection system. It pays to know the condition of the rope. Gauges and micrometers help in determining the real condition of the rope. By inspection, the operator can often detect sources of trouble, such as a faulty sheave, bad crossover, obstruction in the derrick or at other points that may damage the line. It will also tell him when to cut or change ends of the line, or whatever course is necessary in the handling procedure. It is well worth while to set up and maintain a good inspection department and keep records of the rope. The records will tell whether or not satisfactory service is obtained.

Wire rope is an expendable item and its cost today is such that it demands attention cost-wise and safety-wise.



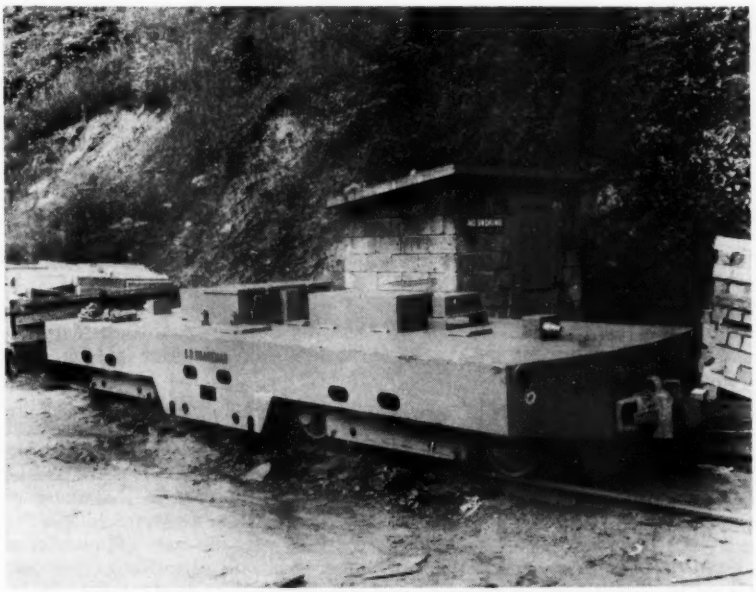
Counterbalanced grooving on a 95-in. diam by 56-in. hoist drum that will use 1⅜-in. rope

THE BRAKEMAN CAR

A magnetic-brake car has eliminated the danger of runaway trips on grades in excess of three percent at Olga Coal, and permitted larger trips to be hauled

By E. J. SERVANT, JR.
Assistant General Superintendent
Olga Coal Co.

LOCATED in southern West Virginia, Olga Coal Co. operates two mines in the Pocahontas No. 4 coal seam. Averaging 78 in. in height, the coal seam is gaseous and deep, having a cover of about 600 ft in the valleys and as much as 1400 ft under the mountains. Interconnected by a track haulage system, the coal from both mines is hauled by trolley locomotives to a shaft bottom, where it is rotary dumped into skips for delivery to the central preparation plant on the surface which prepares about 8500 tons daily. From the most remote section of the mines, the haul is about seven miles. Grades in excess of three percent are encountered on the main haulage ways which are generally in favor of the loads. Coal is hauled in 10½-ton capacity mine cars over 85-lb track to the shaft bottom by 40-ton tandem locomotives. The trolley system is made up of 400,000-CM trolley wire paralleled by 1,600,000-CM aluminum feeder wire fed by Ignitron rectifiers operating at 275 volts d-c. Sectionalizing circuit breakers are installed at rectifier substations with tie breakers at points midway between stations, the substations are approximately a mile apart.



Braking power is achieved on this 8½-ton Brakeman car by the attraction of an electromagnetic shoe to the rail. Each brake shoe has a magnetic pull against the rail of 15,000 lb—a total of 90,000 lb for the six shoes—which is translated to a total braking force of 12,000 lb at 10 mph with normal rail conditions

Larger Cars and Adverse Haulage Conditions Overload Battery Locomotives

Prior to the installation of trolley, which was recently completed except for one section, coal was hauled by storage battery locomotives on both the main line and in the sections. These mines are gaseous and since they were developed before the introduction of high pressure, large capacity axial flow fans, mine management felt at that time that it would be inadvisable to install a trolley haulage system as the supply of air was limited and open equipment might present a hazard. As a result, permissible storage battery locomotives were used throughout the mine since no arcing or sparking could exist. The use of storage battery locomotives having sufficient capacity was possible because the grades were generally in favor of the loads. The total horsepower of a main line locomotive was 120 at 3½ mph, which would have been entirely inadequate had the grades been against the loads.

Larger cars were bought—the present 10½-ton mine cars—before the trolley installation.

Later, less favorable grades with respect to the loads, longer hauls, and an increase in the tonnage per trip loaded the battery-powered main haulage locomotives to the point that they had great difficulty in hauling the coal. A higher capacity unit became a necessity. Since large, high capacity fans had been installed over new air shafts and a sufficient quantity of air was now available, it was felt that the installation of trolley to alleviate the condition was the answer, but this was a huge undertaking—one which would take several years. It was necessary that a quick solution be worked out.

After considerable study, it was decided to use a standard 40-ton

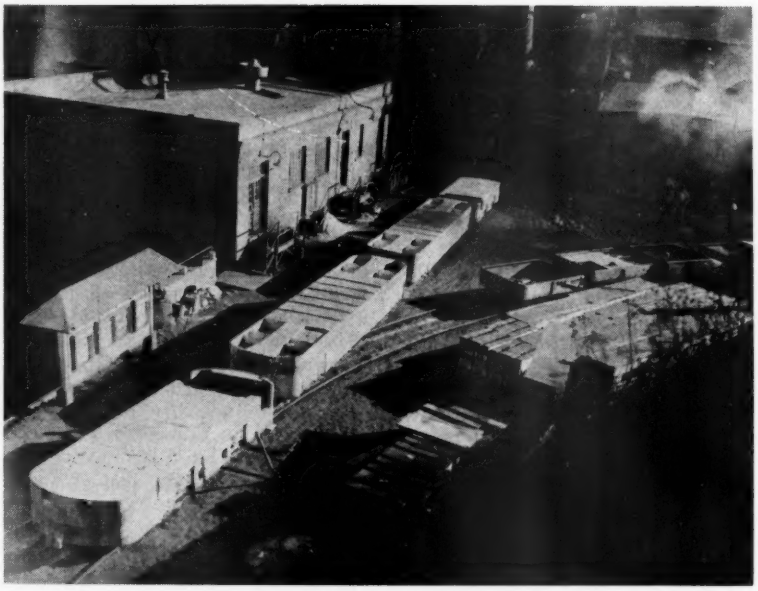
tandem locomotive (460 hp) with two eight-wheel battery trailer cars coupled between the primary units of the locomotive with enough battery capacity to last an eight-hour shift. A 3000-amp hour, 120-cell battery was contained in the two trailer cars which then had a gross weight of 60 tons. Additional battery trailer cars, complete with batteries, were kept for changeout between shifts to allow the batteries to be charged. The locomotive, complete with battery trailer cars, weighed 100 tons and was 104 ft long. The locomotive could be controlled from either unit with complete controls for all functions being available. Braking was accomplished with air brakes on the primary units and battery trailer cars, and dynamic brakes on the locomotive units.

Normally the locomotive could handle 23 loaded mine cars, each carrying 10½ tons of material down a grade exceeding three percent. The eight-wheel mine cars, weighing 16 tons loaded, made up a trip including the locomotive and battery trailer cars of 468 tons, 60 tons of which was trailer car dead-weight. Using dynamic braking, the trip could be kept under control down the steepest grades with a slight application of the air brakes. The maximum speed downgrade was about ten mph. In the event of failure of the dynamic brakes, sufficient air braking was available to stop the trip since both the locomotive units and trailer cars were equipped with air brakes. Although it was cumbersome, slow, and carried much deadweight, the locomotive furnished cars to the sections from which it hauled without any particular difficulty.

Trolley Installed to Increase Efficiency

In an effort to speed up transportation, cut maintenance costs, and in general make the haulage system more efficient, it was decided to install trolley on all main and sectional haulageways. New locomotives were bought for the sectional and secondary haulage replacing the battery locomotives. The 40-ton tandem locomotives on hand were converted to standard separable tandem trolley locomotives, eliminating the battery cars, as this could be done without major change.

Upon the installation of the trolley, it was found that the desired benefits were generally realized. However, there was one exception. The 40-ton trolley locomotives could not handle 23 loaded cars on air brakes down a three percent grade if the dynamic braking system failed, since they did not have the airbraking capacity that had been available when operating with the battery trailer cars. It was necessary for trips to be limited to 17 cars. Even though the empty trips were larger and the speed of the locomotive was increased on trolley power, the fact remained that the required number of loads could not be handled on the steep downgrades with safety.



One of the 104-ft battery-powered locomotives that were replaced by trolley-powered units. The 60-ton battery cars in the center were equipped with air brakes and supplemented the braking power of the locomotive. With the elimination of these heavy cars, braking power became critical

As a temporary measure skids were used under the wheels of the mine cars to allow more loads to be hauled, even though it was not considered a desirable means of control. Where the grades were steep it was apparent that a larger locomotive, an additional locomotive, or additional braking power on the locomotive in use, would have to be made available. Since the purchase of another locomotive was expensive, a means of increasing the braking on the existing locomotive was considered.

Brakeman Car Employs Magnetic Brakes

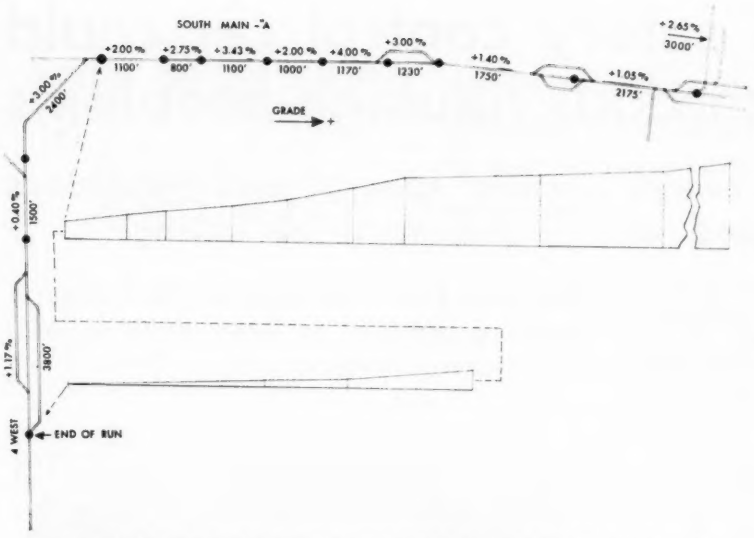
At this point, it was decided to investigate the merits of the Sanford-Day Brakeman Car with the idea of using it as an auxiliary or emergency brake in conjunction with the air brake to supplement it in case of failure of the dynamic brake. It would also be used to aid the dynamic brake down the steepest grades when hauling a large trip.

Sanford-Day engineers were contacted, and after a study of the problem proposed a design of the Brakeman car that seemed to fit the need. It was decided to purchase the car as it appeared to be the most economical means of obtaining the additional braking required.

Weighing about 8½ tons, the Brakeman car is an eight-wheeled unit, 22 ft 4 in. long measured from Willison coupler centers. The wheel centers on each four-wheel truck are 70 in. with 12 ft 1 in. between truck centers. The over-all width is 6 ft 6 in. with an over-all height of 43 in. It is designed to operate on a 150-ft minimum radius horizontal curve. The wheels are 16 in. in diam and equipped with Timken bearings. In normal operation the Brakeman car is coupled between the primary units of the locomotives with all controls and air hoses that are necessary for the tandem's operation passing over the car.

Three sets of magnetic brakes (two shoes per set) are employed, two sets of which are located between the wheels on each four-wheel truck. The third set is located at the center of the car. All brakes are suspended centrally over the rails and parallel to them by means of saddle and mounting springs. The brake shoes, 46 in. long, clear the rail by ⅜ in. Each brake has renewable shoes.

Dual controls allow the brakes to



In the critical 15,000 ft of haulageway, some 5900 ft had grades of better than three percent in favor of the loads

be applied, one set (two brakes) at a time, from either primary unit of the tandem until all three sets (six brakes) have been applied. By means of a double pole switch, reversal of the order of application can be made to equalize shoe wear. As each set of brakes is applied a bulb in view of the motorman lights up to give a visual indication that the set of brakes have been applied.

A 32-volt storage battery is used as a self-contained source of power which keeps the system operative in case of trolley power failure and, at the same time, independent of voltage fluctuations. An MG set with the necessary charging equipment is energized from the trolley to keep the battery in a good state of charge at all times.

Braking is achieved by the attraction of an energized electromagnet to the rail causing the brake shoe which is mounted on the electromagnet to exert a retarding force on the car. When deenergized, the brake is held clear of the rail by spring tension. Each brake shoe has a magnetic pull against the rail of 15,000 lb—a total of 90,000 lb for the six shoes. On dry rail, traveling at 15 mph, the six brake shoes can exert a braking effort of 10,000 lb. The total current pulled is 55 amp.

From the profile map it may be seen that the total critical length of the haulageway is 15,500 ft with grades of three percent comprising less than 12 percent of the total. Operating two shifts a day, and a part of the third, the locomotive makes seven to eight trips per shift. During normal operation the brake car is used as a supplementary brake to the dynamic brake on the steepest parts of the haul only.

Danger of Runaway Trips Virtually Eliminated

Theoretically, the brake car can exert about one-half of the total retarding force required for braking the trip. In the event the dynamic braking system fails, it can be seen that adequate emergency braking is available by making use of the air brakes in conjunction with the magnetic brakes. Usually a failure of the dynamic braking system involves only one unit of the locomotive, but emergency capacity is available just in case it is needed. Since installation of the Brakeman car, two trips, potential runaways, have been brought under control. As a result, the motormen operate the locomotive with great confidence knowing that they are able to control the trip under emergency conditions.

The brakes of the car are used on straight sections of track only. Contact with the rail is limited on curves because the full surface area of the brake shoe cannot come into contact with the top of the rail, and braking is not as effective under these conditions. Since it is normal procedure to slow down when approaching a curve this does not present a serious problem.

As a note of interest, if the magnetic brakes are applied to a light locomotive when stopped, the locomotive cannot move even with full power being applied because of the holding power of these brakes. As the speed increases and an application of braking is made, the braking becomes less effective since the coefficient of friction decreases with an increase in speed.

It has been found that as the shoes wear and conform to the contour of the rails the braking is improved. This situation is similar to the breaking in of conventional brake shoes.

The Brakeman car has been in operation over a year with very little being needed in the way of maintenance and repair except to replace the original brake shoes at the end of 12 months. No other parts of the car have been replaced. A regular inspection of the locomotive and the car is made each five working days to assure dependable operation.

There is probably some speculation as to what might happen to the suspended magnetic braking mechanism when the locomotive and car are derailed. It can be said that no damage has resulted to date, although the car has been off the track many times. Only a reasonable amount of precaution need be exercised in rerailing it, so as not to damage the brakes. During derailment, the brakes move upward into a protected position.

Economically, the management at Olga feels it has served its need for additional locomotive braking capacity without having to purchase costly additional or larger replacement units, and without having to resort to undesirable skids or other devices that would reduce the reliability and efficiency of the main haulage system. From the standpoint of safety it can be said that the danger of runaway trips has been virtually eliminated.

Calculation of Braking Force

Trip consists of:

		lb
1	40-ton tandem locomotive	80,000
1	Brakeman	17,000
23	Cars, 16 tons each	736,000
	Total weight, 416.5 tons	833,000
	Force down 3 percent grade equals 833,000 × 0.03 =	25,000
	Less 4/10 percent friction (8 lb per ton)	3,300
	Net force downgrade	21,700
	Braking force from 40-ton locomotive, 80,000 × 20 percent	16,000
	Braking force from Brakeman at ten mph based on typical rail conditions	12,000
	Total expected braking force	28,000
	Available for stopping, or for handling additional cars	6,300

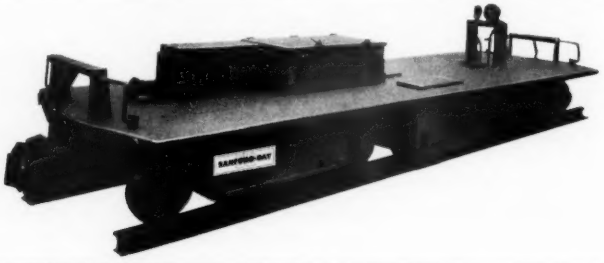
S-D Brakeman® safety control car could solve your hazardous haulage problems

Now potential break-aways, unsafe speeds and hazardous threats can be disposed of . . . and at great savings!

The S-D Brakeman is a safety control car that incorporates electrically operated magnetic brake shoes. It slows or STOPS when nothing else could . . . ASSURES SAFETY at the least possible investment and cost.

Here are a few of the many S-D Brakemans designed and built to meet multitude of customer requirements . . .

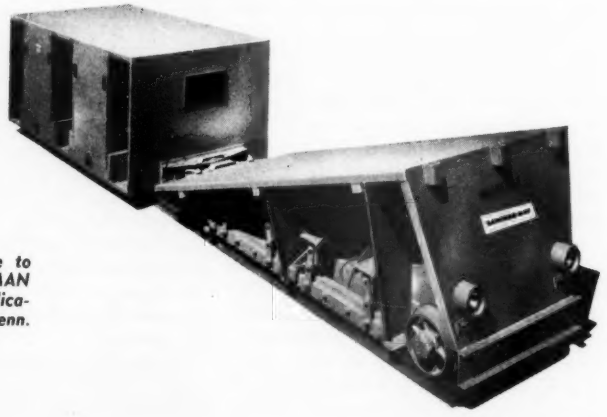
COSTLY USE OF A TRAILING LOCOMOTIVE REQUIRING OPERATOR FOR BRAKING PURPOSES WAS ELIMINATED and released for productive use by substituting this S-D Brakeman, featuring three-pair of brake shoes and developed specifically to dispose of hazardous haulage threats. SAFETY WAS ASSURED! COSTS WENT DOWN!



MANAGEMENTS WANTED TO ASSURE MINERS ABSOLUTE SAFE TRANSPORTATION . . . ordered S-D Safety Control Trains, like this one and of other types, equipped with dual-purpose Personnel and Materials Handling S-D Brakeman. AGAIN ASSURING SAFETY . . . BUT COSTS WENT DOWN!

LOCOMOTIVE BRAKING WAS INSUFFICIENT . . . so several mines have put S-D Brakemans similar to this one, also available with two-pair of brake shoes, into service to ASSURE SAFETY at far less investment. BIG PLUS FEATURE: Permitted additional cars to be added to trips! Substantial increases in trip PAYLOADS!

PROTECTION AGAINST DAMAGE OR WRECKING EXPENSIVE MACHINERY AND EQUIPMENT BEING LOWERED INTO UNDERGROUND WORKINGS has been ASSURED in several mines by this S-D Brakeman. Failure or breakage of rope no longer presents a threat with this S-D Brakeman, or one similar to it, there to STOP MOVEMENT . . . HALT THE TRIP until repairs to rope or lowering mechanism can be made.



No mine should be without the BULLETIN A-400 for reference to positive, proved solutions to unsafe problems with an S-D BRAKEMAN designed and built to meet requirements. Write for this FREE publication today. Sanford-Day Corporation, 620 Dale Avenue, Knoxville, Tenn.

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MINE HAULAGE AND EQUIPMENT BUILDERS FOR 60 YEARS

Job Hazards Analysis

Accident statistics provide information that can be put to work to improve safety performance

By P. M. WADSWORTH
Safety Director
Climax Molybdenum Co.

THE Climax Molybdenum Co. is the largest molybdenum producer in the world. The plant is operating seven days a week on a five-day workweek, and is producing 34,000 tons of ore every 24 hours. The company employs about 2000 people, including management and supervision.

The Climax mine is located in Colorado, 100 miles southwest of Denver and 13 miles northeast of Leadville. It is directly on top of the Continental Divide of the Rocky Mountains. In fact, the Phillipson Level adit is on the western watershed, and the Storke Level adit is on the eastern watershed. The main mine workings range from 11,180 ft to 12,000 ft in elevation.

As is to be expected at this elevation, the winters are long. Snow conditions exist from the last of October through May. Temperatures may drop to 30° below zero, and it is not uncommon for temperatures to remain below zero for several days at a time. The mine is damp and cold with an average temperature of around 40°.

The caving method of mining is used at Climax. Ore is hauled out of the mine in ten ton side-dump cars, with approximately 20 to 24 cars to the train. On the Phillipson Level the ore is crushed with primary jaw crushers and is then further reduced with cone crushers. On the Storke Level a 60-in. gyratory is used for primary crushing, and then the ore is fed through cone crushers. After crushing the ore is transported by conveyors to the mill where it is ground and a concentrate produced by flotation.

The principal product is molybdenum; by-products are tungsten, tin, and pyrite. The molybdenum leaves the mill as molybdenum sulfide, which is dried in a modern drying plant located on the property. It is then shipped to Langeloth, Pa., for further refinement.

Preliminary Preparation for Job Hazards Analysis

The purpose of this article is to demonstrate the importance of job hazards analysis and how it can be used to improve a safety program.

At Climax, an injury report card must be turned in on each accident. This card is made out by the injured employe and signed by himself and his immediate supervisor. The injured person and the supervisor both fill in the cause of the accident about which there is usually agreement. However, when they do not agree, both men are interviewed by a member of the safety department who determines the cause. The following additional information is also furnished on this card—the man's name, work number, the shift he was working, day of the week, time of the accident, part of the body injured, and extent of the injury. This information is transferred to an IBM card.

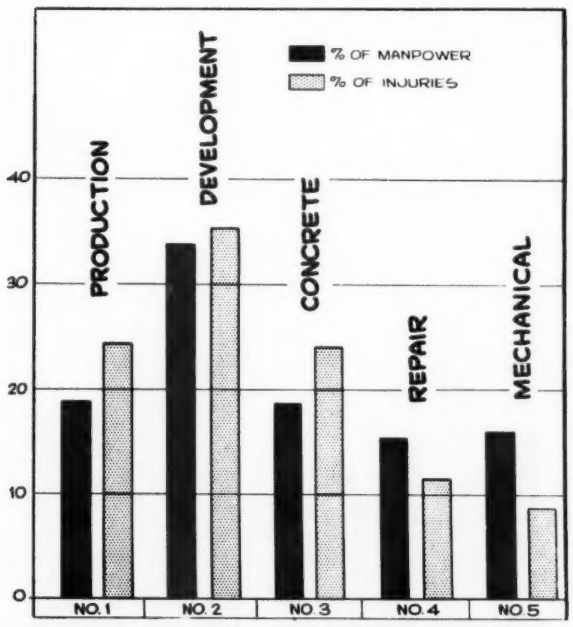

Fig. 1. Percentages of injuries compared to manpower. Note the percentage of employes compared with the percentage of accidents in each of the five divisions. The production, development and concrete divisions have a higher ratio of injuries per employe than do the other two divisions. This indicates that more work is needed in these three divisions

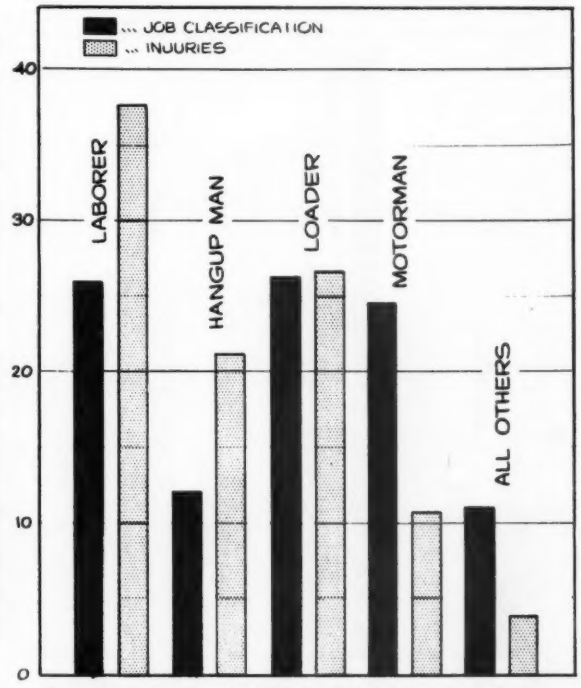

Fig. 2. Percentages of injuries in production crews compared to job classification. It can be seen that laborers and hangup men have a high ratio of injuries considering the percentage of men employed in these categories

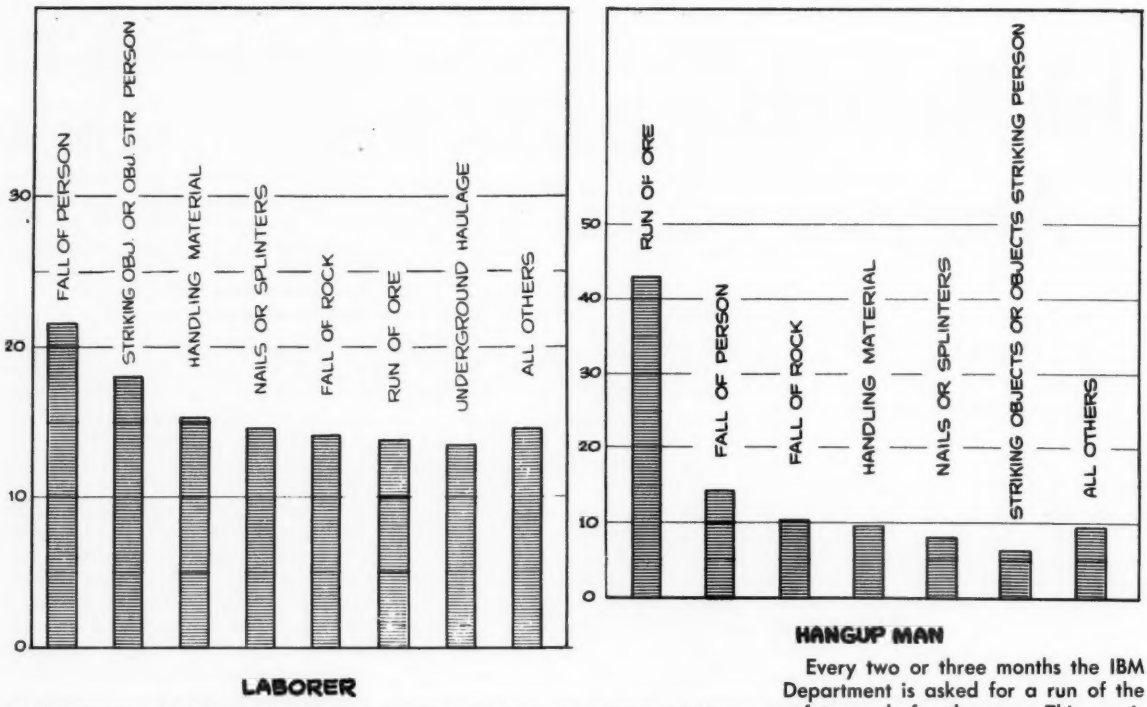

Fig. 3. Percentage of injuries by physical agencies among production crew laborers and hangup men. These two job classifications were broken down in an effort to determine exactly how the accidents were occurring. Among the laborers, the most common cause for injury was "fall of persons," while in the hangup man classification, the most common cause was "run of ore." The same procedure was followed in the Development Division, which is composed of miners, laborers, pipemen and a small number of other miscellaneous job classifications (see figures 4 and 5)

Every two or three months the IBM Department is asked for a run of the safety cards for the year. This run is then checked to see if a definite trend exists. There are over 5000 punched cards, dating back to 1954, and any variation from the normal in two or

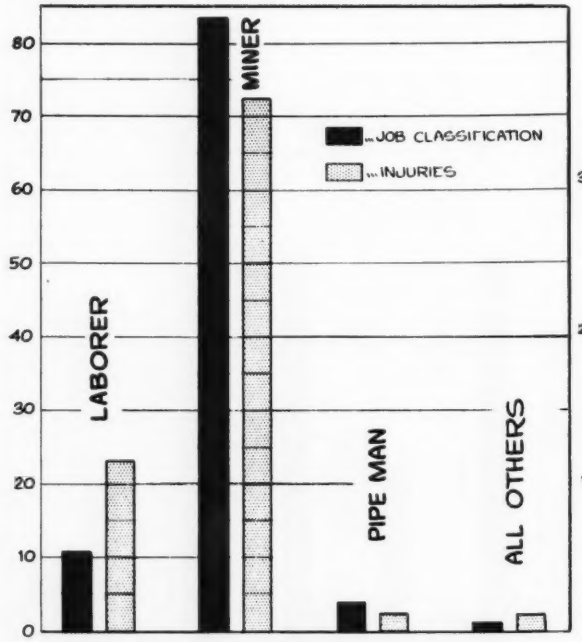

Fig. 4. Percentages of injuries compared to job classifications in development crews. It will be noted that the ratio of injuries to employes is much higher in the laborer classification than in any of the others. These are the employes who should command immediate attention

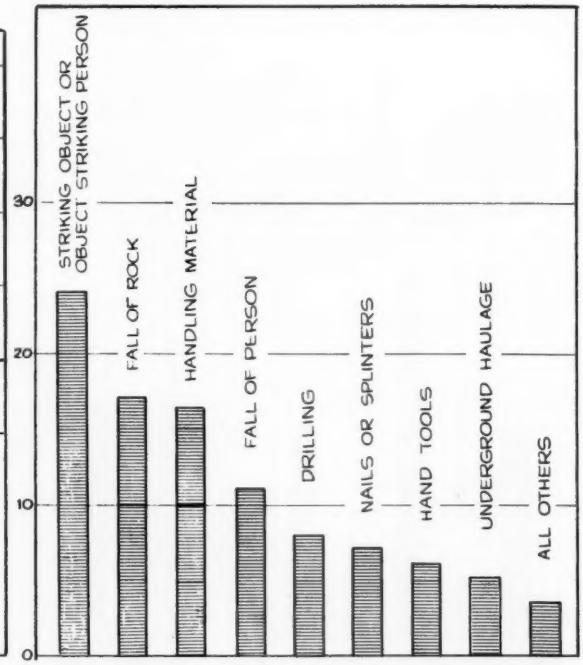

Fig. 5. Percentages of injuries by physical agencies among development crew laborers. Most injuries occur when an employe strikes an object or is struck by one. This includes bumping into machines, being bumped by machines, bumping into the ore body, or hitting oneself with drill steel, lumber, etc.

three months' cards can be easily detected. This gives a very good background for determining what is causing accidents and thus gives a definite goal toward which to work in preventing them.

The remainder of this article will be concerned only with accident data from the Mine Department. The department is broken down into five divisions for purposes of analytical and statistical work. These are production, development, concrete, repair and mechanical. The reader should now study figures 1 through 8 and their captions.

Putting Job Hazards Analysis to Work

Having collected and organized the necessary data; and having analyzed it, the data should be put to work by taking definite corrective steps.

On some jobs, closer inspections may be necessary; others may require slight alterations in procedures. In some cases more intensive instruction may be the answer. Perhaps more and better safety meetings will be necessary. Additional safety equipment may be indicated. Job hazards analysis shows what the needs are and where they exist. With it the company is better prepared to find solutions to safety problems and improve safety performance.

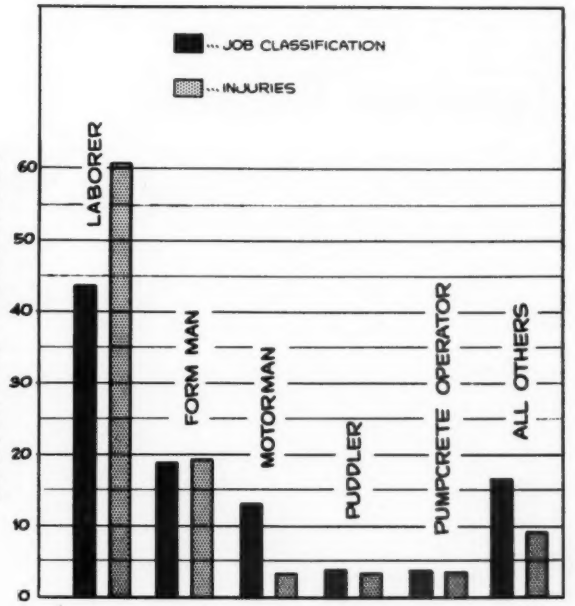

Fig. 6. Percentages of injuries compared to job classifications in concrete crews. Here again laborers are the principal source of accidents as compared to the percentage of employes in this classification. The Form Man (employe who builds forms for concrete work) classification, also has a slightly higher percentage of accidents than it should have for the percentage of manpower

In summation, it can be concluded that job hazards analysis has four major objectives:

1. To establish a written breakdown of a job that can be used by supervisory personnel for training.
2. To analyze a specific job with the idea in mind of eliminating all hazards that are found to exist in it.
3. To determine what equipment and tools are needed for safe operation.
4. To establish a basis that can be used in connection with proper selection of employes.

Of all the fundamentals of accident prevention that have been applied, job hazards or job safety analysis has perhaps received less usage in the mining industry than any other one means of accident prevention. The author hopes that he has demonstrated the beneficial results of applying it.

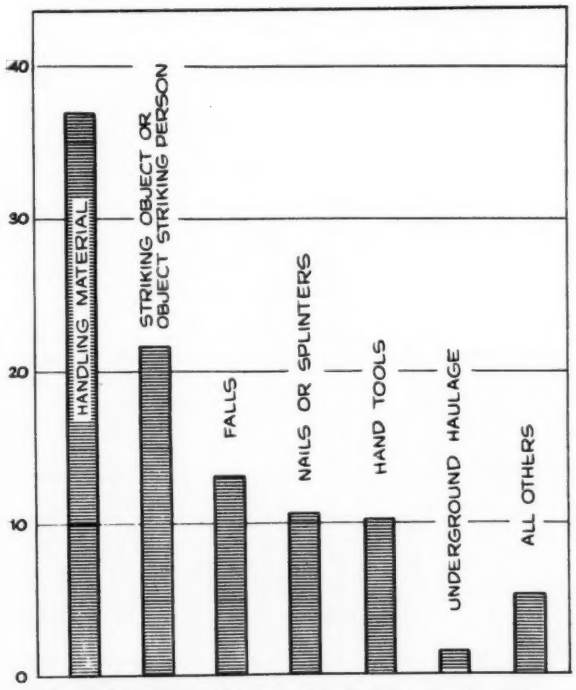

Fig. 7. Percentages of injuries by physical agencies among concrete crew laborers. Breaking down the cause of injuries, it was found that the most common cause or agency was "handling material"

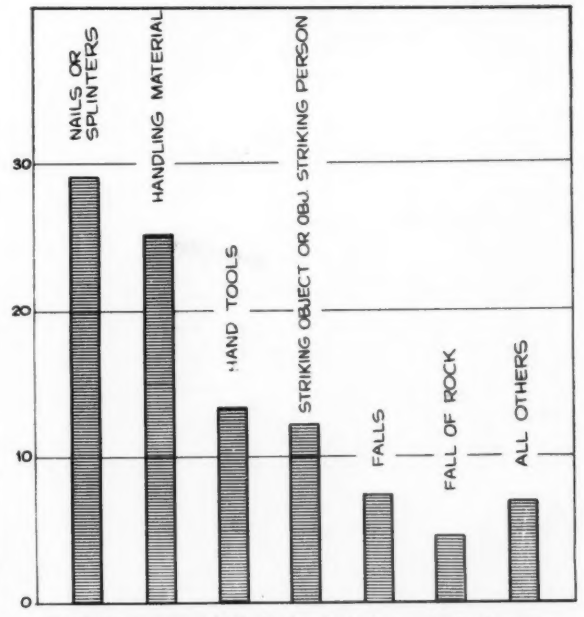

Fig. 8. Percentages of injuries by physical agencies in the concrete crews Form Man classification. The most common cause of injuries in this classification was nails or splinters left in lumber or in concrete

Tensional Behavior of Floor Bolts in Advancing Longwall Coal Mining

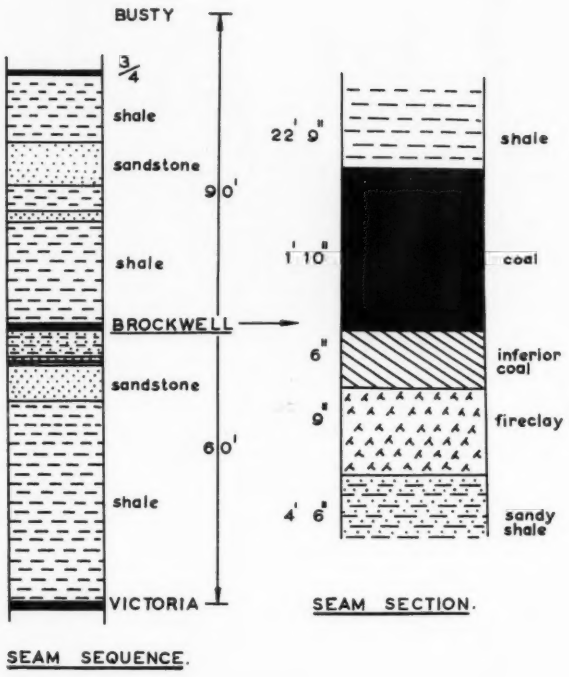

Fig. 1. The 22-in. Brockwell seam is mined by advancing longwall

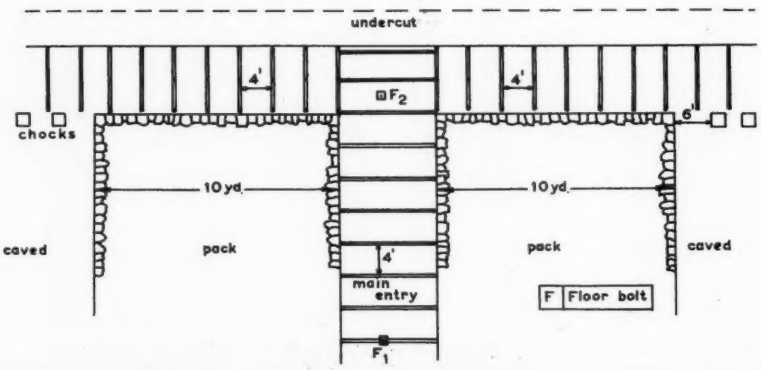

Fig. 2. Mining plan shows systematic roof support with wooden props and bars set at four-ft intervals. A longwall coal cutter advances the face 4 ft 6 in. with each cut

IN the main entry to a double unit, advancing longwall face in the Brockwell seam at a colliery in the Durham division of the National Coal Board in England, considerable trouble had been experienced due to floor "heave." At a distance of between 80 and 90 yd behind the face, the floor was breaking up and tending to close the entry. The Brockwell seam had an average height of 22 in. in this area. A section of the seam and associated strata is shown in figure 1.

The main entry was brushed up to the coal face in both the roof and the floor to accommodate 12 ft by 8 ft rigid steel arches. Packwalls, 10 yd wide, were built on each side of the main entry. The face was undercut with a longwall coal cutter to a depth of 4 ft 6 in., the coal fired down with explosives and hand-loaded on a conveyor. The roof at the coal face was supported by wooden props and bars set at four ft intervals with wooden chocks set along the waste edge at six-ft intervals, behind the props and bars. The roof was allowed to cave into the waste behind the chocks. Figure 2 shows diagrammatically the support system adopted in the main entry and on the face.

In an attempt to overcome the problem of floor "heave," floor bolting was introduced in the main entry and this measure met with considerable success. Figure 3 is a view look-

British investigation shows heaving bottoms can be controlled by setting roof bolts in the floor

By RICHARD J. SMITH, Post Graduate Research Student
and GEORGE M. PEARSON, Lecturer in Mining Engineering
King's College, University of Durham, England

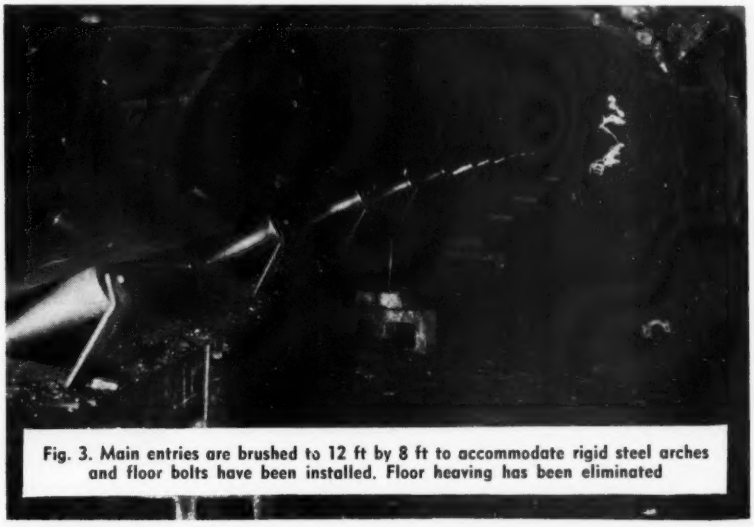

Fig. 3. Main entries are brushed to 12 ft by 8 ft to accommodate rigid steel arches and floor bolts have been installed. Floor heaving has been eliminated

ing outwards along the main entry after floor bolting had been in operation for some time. Bayliss, Jones & Bayliss, ¾-in. diam wedge and sleeve bolts, 4 ft 6 in. long were installed daily on 8 in. by 8 in. by ¼ in. steel plates a a distance of approximately 12 yd back from the brushings. The installation pattern is shown in figure 4, while figure 5 shows the equipment used to set the bolts. All bolts were tensioned with a torque wrench to a torque of 150-lb ft.

This particular installation provided an opportunity to study the behavior of floor bolts which were obviously improving conditions in the entry. At the same time the effect of operations at the coal face on floor bolts was investigated.

Load Cells Used to Determine Bolt Tension

Load cells developed in the department of mining engineering, King's College were used to measure bolt tension which is one of the factors by which one can assess the effectiveness of a bold.[1, 2] The load cell consists essentially of two members, an inner cylinder with top and bottom plates integral with each other and an outer protective cylinder sealed against the ingress of moisture by two Gaco "O" rings, figure 6. Eight wire resistance strain gauges, four active and four compensating, are bonded in a uniform stress field around the inner

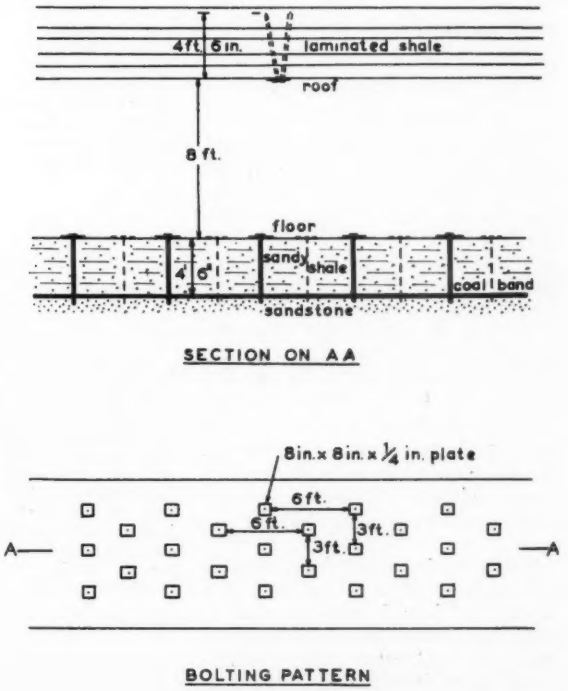

Fig. 4. All floor bolts used in the test were anchored in sandstone in 1-11/16 in. holes (standard size in British coal mines), drilled with a hand-held rotary drill. Hole diameter control was assured by replacing bits when they measured 1/32-in. undersize

cylinder. The strain gauges are protected against the ingress of moisture by filling the instrument with mineral oil. Electrical connections are brought to a Plessey plug fixed to the outer cylinder, forming a complete bridge within the cell, to which a recorder or indicator unit can be connected. A spherical seating, set in a mild steel locating ring which passes over the instrument, eliminates the effects of eccentric loading.

Prior to and after use, each load cell was calibrated in a testing machine in a laboratory under loading conditions similar to those experienced in the mine. Figure 7 shows a typical calibration curve for one of the cells.

In the initial stages, when comparatively rapid changes in tension were to be expected, readings from load cells were recorded on a Thread Recorder. This recorder consists essentially of a moving coil galvanometer. the pointer of which is depressed by a chopper bar onto an ink impregnated thread. A continuous record of bolt load is obtained as a series of closely spaced dots on a chart attached to a clockwork driven drum. In the later stages, when changes in tension were less pronounced, spot readings were taken from the load cells on a microammeter. This microammeter has a range of ten microamps with the smallest scale having a division of 0.1 microamp. Figure 8 shows one of the floor bolts with the load cell in position and coupled up to the microammeter indicating unit.

Bolt Tension Measured Under Various Conditions

Figure 9 shows the tension in a center floor bolt (F_1, figure 2), set initially some 40 ft back from the face, as the face advanced. At this distance back from the face it was only possible to achieve a maximum setting tension of 1.3 tons and this fell off rapidly to 0.75 tons, probably as a result of anchor slip. Thereafter the tension fell off gradually until it reached a value of 0.15 tons when the face was 72 ft away. When the face was 87 ft away, the tension suddenly began to increase and when the test had to be discontinued with this particular bolt 128 ft from the face, the tension had reached a value of 1.1 tons.

Figure 10 indicates the tension in a floor bolt specially installed at a distance of four ft from the face to study the effects of face operations. When the coal cutter was some distance away along the face, this bolt

The Bayliss wedge and sleeve bolt used in the floor bolt tests consists of a bar and a split sleeve. At one end of the bolt is a cold-rolled thread while at the other end is a solid wedge, forged integral with the ¾ in. diam bolt rod. Over the wedge is fitted a loose split sleeve 1½ in. outside diameter

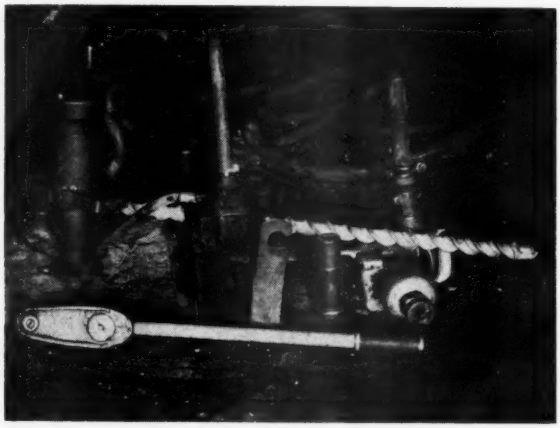

Fig. 5. Bolt setting equipment included a torque wrench used to tighten all bolts to a torque of 150 lb ft

Fig. 6 Load cells were used to measure bolt tension directly. Eight strain gauges are contained in a moisture-proof inner cylinder

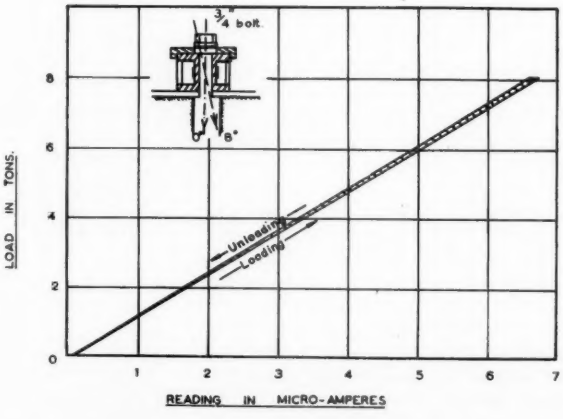

Fig. 7. Prior to and after use each load cell was calibrated in a testing machine. Here a typical calibration curve shows the load in tons versus the reading in micro-ampheres

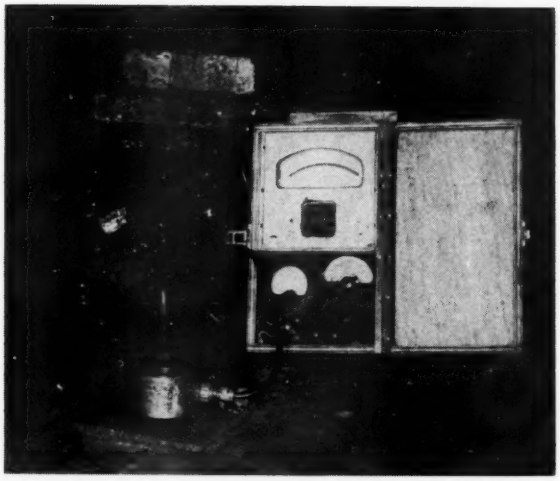

Fig. 8. Load cell is shown attached to an installed bolt with an electrical connection to an indicator

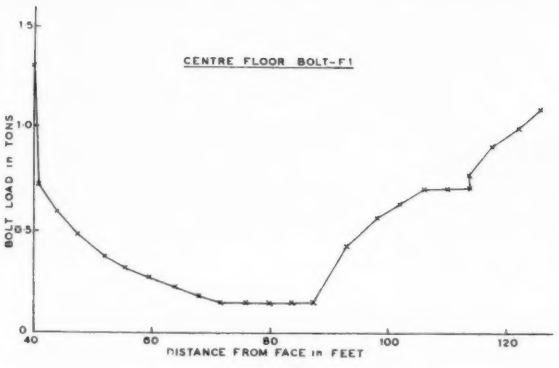

Fig. 9. The tension on bolt F-1 increased substantially as the face advanced away from the bolt

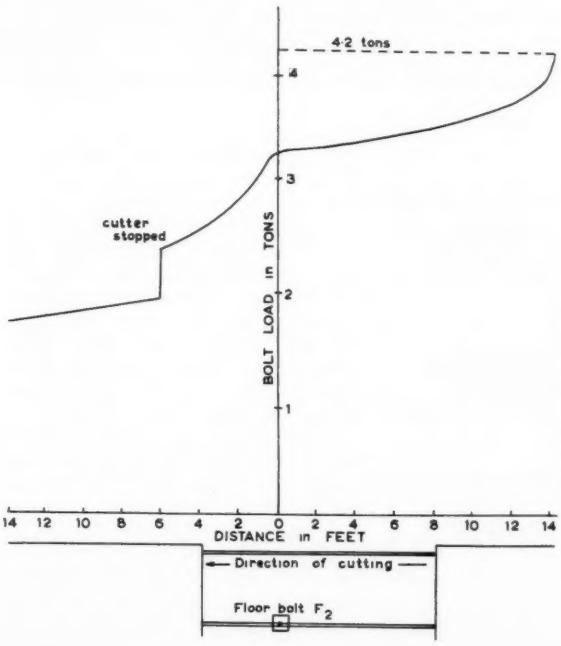

Fig. 10. Tension on bolt F-2 located four ft from the face decreased as the cutting machine proceeded along face. Cutter operations had no effect on the tension of bolts placed 12 to 13 yd from the face

had a tension of 4.2 tons. At 12 ft away the tension dropped off sharply to 3.7 tons. The rate of loss of tension decreased, becoming uniform until the cutter was two ft past the bolt when there was a drop of almost 0.5 tons. At six ft past the bolt, the cutter was stopped for 6.5 minutes during which time there was a drop in tension from 2.5 tons to 1.9 tons. When cutting was restarted the rate of loss of tension again became uniform. While the cutter was cutting through a distance of 28 ft across the head of the main entry, the tension in the bolt dropped from 4.2 tons to 1.7 tons. Unfortunately, it was impossible to carry out further tests on this bolt since the load cell was interfering with the moving forward of the face conveyor driving motor. Face operations had no noticeable effect on the tension of the floor bolts installed in their normal position some 12 to 13 yd back from the face.

Bolting a Means of Preventing Floor Heave

Bolting was extremely successful in preventing floor heave as can be seen in figure 3. The build-up in tension in the bolt which commenced 90 ft back from the face would be at the point at which the floor of the roadway, prior to bolting, would have shown signs of deterioration. Heave was beginning and the shale was breaking at a thin band of coal. This was prevented by the bolts which were anchored in the strong sandstone beneath the thin band of coal. It is probable also that the packs were becoming well consolidated and transferring load to the floor at this distance from the face, so initiating the heave.

Although limited in extent, this investigation does show the potential value of bolting as a means of preventing or reducing the magnitude of floor heave. The investigation also served to emphasize the need to set bolts as close to the face as possible and the need for periodic retensioning in association with a simple device to indicate bolt tension.

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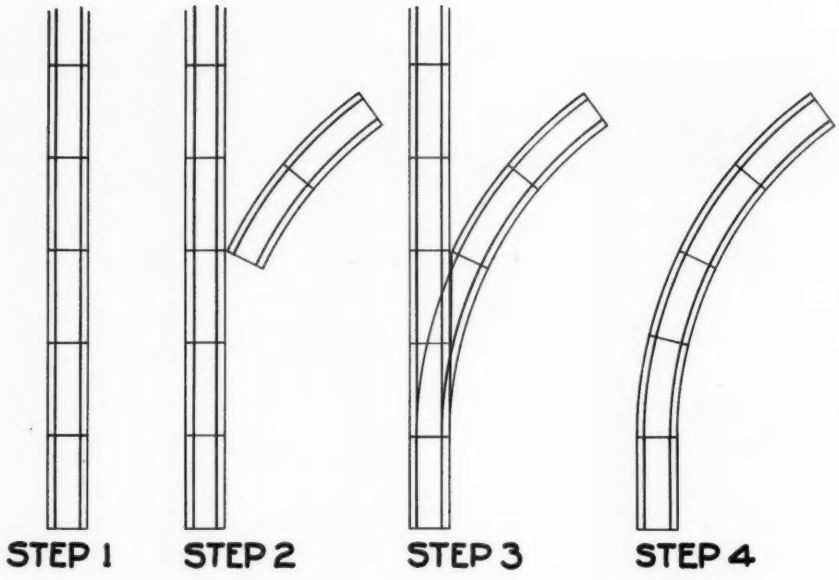


Fig. 1. Use of prefabricated sections makes it possible for a two-man crew to reroute and lay complete rail systems

Trends in Underground Rail Loading and Tramming

By JAMES W. CLARK
Manager
Mining Machinery Division
Lake Shore, Inc.

New track laying techniques, improved mine car designs and automatic haulage systems are advances that are creating renewed interest in rail haulage

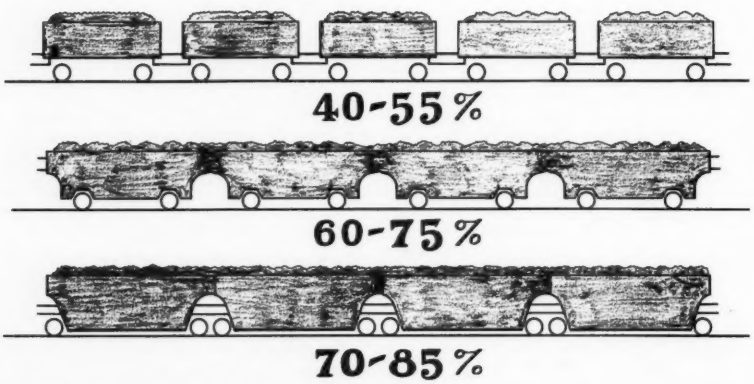


Fig. 2. The volumetric efficiency of car displacement is dependent on design. Improved mine car designs provide greater cubic capacity for given over-all dimensions

IN recent years there has been so much development in the conveyor and shuttle car fields that underground rail haulage has, in the minds of some, become "old hat" and outdated. Manufacturers of mine cars and related equipment have been somewhat lax in development of automated systems, but recent trends indicate that some noteworthy advances in this field have caused new concepts in mine plant design.

Development along these lines has been slow due to the fact that it has required close coordination between four general factions; these being, the mining company, the locomotive producer, the mine car manufacturer and the electrical control supplier. This has made coordination of better methods quite cumbersome, and

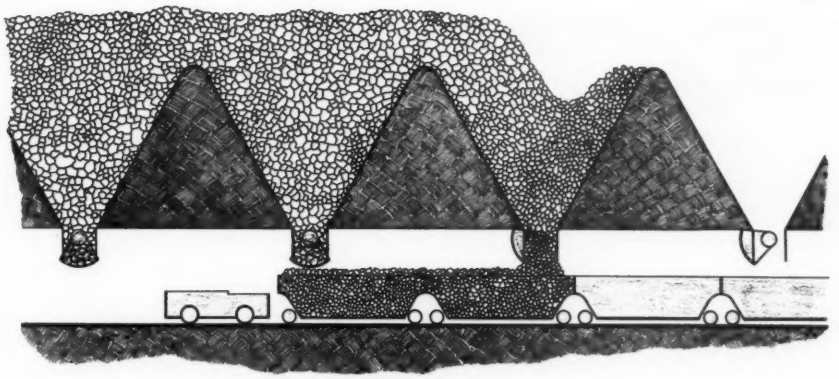


Fig. 3. In block caving operations, automatic car loading can be achieved by means of limit switches for actuating chute gates and for probes indicating that cars are empty

mining companies have taken the course of swinging toward conveyors and shuttle cars for material movement, which have shown marked improvements in many cases in materials handling costs.

However, a rather startling fact has come to the attention of car and locomotive manufacturers. That is, that some of the mines which have been conveyor and shuttle car minded in the recent past, are now swinging back to the use of cars. This is due to several factors: (1) the flexibility of rail haulage; (2) the maneuverability of drift location; (3) the fact that material can be stored in cars without expensive underground storage installations; (4) automation of haulage systems; (5) marked improvements in loading and dumping; and (6) faster tramming speeds.

Therefore, in the field of material handling underground, the manufacturers of rail haulage equipment should continue their efforts to improve their products and the mine operators should give full consideration to mine car haulage in comparison to other methods when contemplating mine plant design.

The purpose of this article is to point out advances that have cut tramming costs to as much as one-third that of previous tramming costs.

New Track Laying Techniques

First, consider improvements to track. Swedish engineers have done much in regard to the flexibility of laying track and also in the realm of making it movable from worked-out portions of mines to new portions. One can compare their system to that of a sectionalized rail set of a children's electric train set, complete to the point of having curves, switches, crossovers, etc.

During a recent trip to Sweden, we were given a demonstration in track laying (figure 1) and it was most impressive to see how fast a two man crew could reroute and lay complete rail systems. It was understood that the mining company which developed the system illustrated in figure 1 has applied for patents in the United States, and that arrangements are being made to license one of the major light rail producers here to manufacture these sectioned components for distribution in this country.

Advantages of Modern Mine Cars Noted

Another major factor in the reduction of rail haulage costs is improved mine cars. In general, modern cars have the following advantages over older types.

(1) Less car weight allows more payload.
(2) Lower center of gravity and better wheel suspension allow much higher tramming speeds with less track and wheel maintenance.
(3) Overlapping cars make continuous loading of trains possible without stopping trains.
(4) Continuous dumping characteristics coupled with continuous loading characteristics make tramming possible without stopping trains.

Some manufacturers have found that aluminum alloys can be used in cars handling various types of ore. Newer designs also make it possible to obtain greater cubic capacity for given over-all dimensions.

The center of gravity is lower on newer types of cars, and this tends to increase the stability of the cars (see figure 2). Increased stability plus fully cushioned suspension has resulted in less rail and wheel maintenance, and also permits tramming at higher rates of speeds.

In recent years manufacturers have

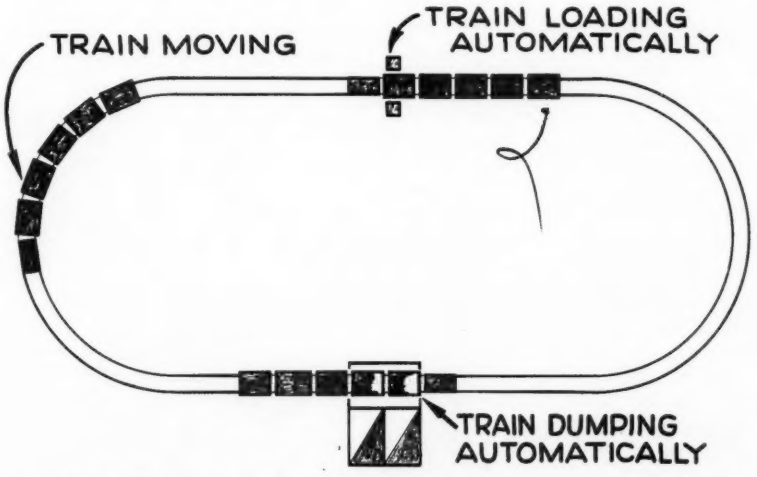


Fig. 4. Arrangement of haulage system for facilitating the use of automatic train loading and dumping

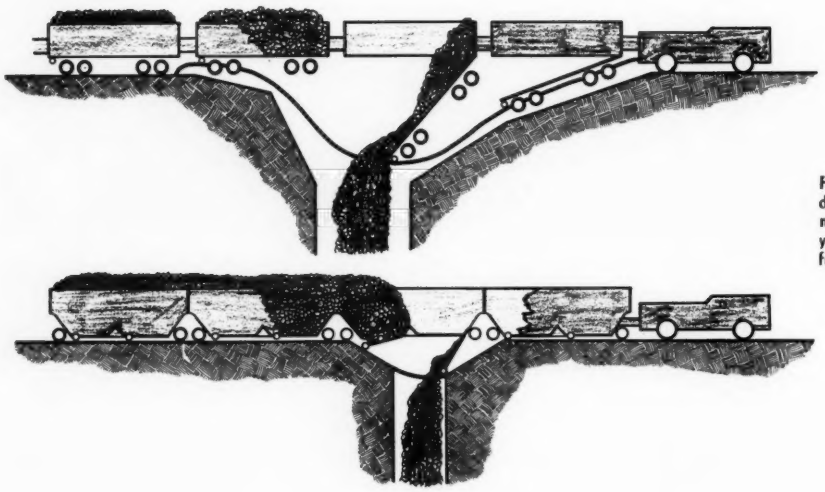


Fig. 5. Various types of continuous dumping cars have been made for many years, but only in recent years have bottom-dump cars with full bottom opening been used to any degree

developed various schemes to overlap adjacent cars. This was quite an undertaking due to the fact that there is considerable relative motion between the ends of adjacent cars. However, the overlapping characteristic has now been perfected and this changes the whole concept of underground haulage.

Automatic Car Loading for Block Caving Operations

In block caving operations where cars are loaded at regular intervals along a drift direct from finger raises, it is possible to operate gates by means of the passing train. When an empty car arrives in front of a raise gate, the gate automatically opens and continues to feed ore until the end of the train arrives (figure 3). At this time, the gate closes. If flow from this given raise ceases before the end of train arrives, the next raise gate will start filling where the previous gate left off. This automation is accomplished by two control actuations. As the first car reaches position under the gate, a limit switch is activated which causes the raise gate to open provided a probe cable hanging in the car indicates that it is empty.

Should a raise hang-up or mechanical failure of any gate occur that would stop flow of ore, the motorman merely calls a crew to indicate that a given raise needs attention. The correction can be made at the convenience of the crew without any interruption or delay of the train loading for the train will automatically draw from the following gate as long as one is hung up.

Another method of automated control for train loading is that of remotely controlling locomotives by probes in the car. When a specific section of a car is loaded, a probe will cause the train to advance. This system can be used in conjunction with any "over-the-side" method of feeding the cars.

In one extensive mine plant conversion, it is anticipated that a train may be left at a scraper loading station for semi-automatic loading. In the meantime, the motorman rides in a motorized personnel car to a second train that has been loaded in another section of the mine to haul it to the dump while the first is being loaded by the scraper operator.

Automation of Car Dumping—Skip Hoisting Cycle

Various automation schemes have been developed in regard to dumping of cars (figure 4). Of course, nothing can beat non-stop dumping where there is ample storage beneath the dump area. Various types of continuous dumping cars have been made for many years, but only in more recent years have bottom dump cars with full bottom opening been used to any degree (figure 5).

One might think that single dumping or spot dumping is inefficient, but it does have some attractive features. Now that automatic train feeding through dump areas can be accomplished, it is practical to carry surge storage in trains themselves, thus eliminating costly storage pockets, skip loading equipment, etc. The actual advance of the trains and the programming of the car dump cycle can be sequenced with the operation of skips. While the skips are traveling, the train is respotted and the instant the skip arrives, the car dumps its load directly into the skip in a five second interval. In this case, the hoisting is completely automatic and should tramming be interrupted for any reason, the skip will wait for the next car.

Costs have also been greatly reduced in the field of rail haulage due to remote automatic control of trains and conversions of locomotives in existing operations to tandem automatic and semi-automatic operations.

In summary, improvements in the field of rail haulage and loading have just begun. When planning new mines or modernization of existing mines, the various possibilities of rail haulage should not be overlooked. The degree to which rail systems can be automated is now outstanding and present developments indicate more developments are coming to further enhance this picture.

Operators' Corner

Fire Control System Built into Coal Cutter

THE Semet-Solvay Division of Allied Chemical Corp. has developed a system of fire protection for its coal cutting machines in an effort to provide greater safety for mine personnel as well as reduce possible damage to the machines.

The new system, developed in cooperation with engineers of the Ansul Chemical Co., Marinette, Wis., producers of dry chemical fire equipment, involves the use of fire extinguishing equipment installed on 11-RU cutting machines. The system is capable of expelling 30 lb of dry chemical into the cutter's cable reel section when a fire breaks out. The system is operated manually. In all, Semet-Solvay has about 30 such machines in its two mines at Tralee and Harewood, W. Va.

The main fire hazard on the cutter is in the cable reel section.

Semet-Solvay's main protection against such fires has been to place 30-lb dry chemical extinguishers in each section of the mine. Sometimes, however, these extinguishers may be as far as 200 to 300 ft away from a machine when a cable fire breaks out, and may become inaccessible because of smoke or flame.

With the new system, a dry chemical extinguishing agent is expelled through flexible hose to the manifold surrounding the back shield of the reel. The manifold is equipped with two nozzles spaced around the shield.

When the operator discovers a fire in the reel, he can depress a puncture lever which results in flooding the reel compartment with dry chemicals.

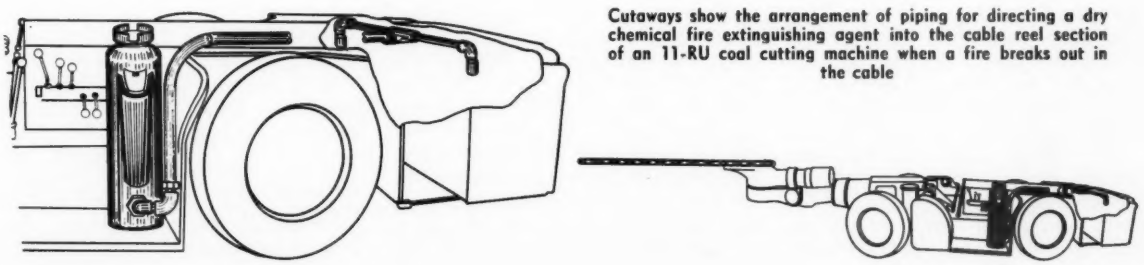
The first such unit was installed about a year ago. Today, as each machine is taken out of service for overhaul, the new fire extinguishing system is being installed. The company plans to eventually have the system on all of its 11-RU's.

Galvanized Rail has Long Service Life

By hot dip galvanizing rails which are used to carry heavy loads, a number of Dutch coal-mine operators are now getting up to three times the service life previously experienced with uncoated steel rails, according to the American Zinc Institute.

Information from the Stichting Doelmatig Versinken (the Dutch galvanizing trade association) shows that conventional steel rails formerly used in Dutch Coal mines became corroded and unsafe after two to three years as a result of constant exposure to water, humidity, and aggressive chemical attack. Since applying a protective zinc coating by hot dip galvanizing, it has been found they can be relied on for from five to six years of efficient and safe, heavy-duty service.

Conditions at the mine depths, generally 2000 to 2200 ft down, attack rails heavily, and every year of gain has a significant effect on maintenance costs. Since most of the mines contain water at elevated temperatures and have sulphate and sulphide content, unprotected steel rails corrode at an accelerated rate. The rails were coated with from 3.2 mils to 4.0 mils of zinc. While the zinc was eroded away by friction on the bearing surface of the rails, this was of no importance since the same friction removed any trace of rust that would tend to develop here. The area where significant corrosive attack was met by hot dip galvanizing involved the sides and base of the rail.



Cutaways show the arrangement of piping for directing a dry chemical fire extinguishing agent into the cable reel section of an 11-RU coal cutting machine when a fire breaks out in the cable

As Viewed by HENRY I. DWORSHAK of the American Mining Congress

One of the most controversial items on the agenda of Congress during the 1962 session will be the forthcoming Administration proposal to extend—and perhaps broaden—the expiring Trade Agreements Act, according to Senate Majority Leader Mansfield (Dem., Mont.). Because of the growing impact of imports on various segments of the domestic economy, Mansfield said, some members of Congress who have been among the strongest supporters of the trade program "now must be listed as critics of it, or at least put in the doubtful category."

He also said that if the House passes a program of medical care for the aged as part of the Social Security system, the Senate probably would approve it. Mansfield said the same is true of proposals to revise the tax laws and incentives for business plant investment, all of which must originate in the House because of their revenue-producing aspects.

The Senate Majority Leader added that the President would make a "vigorous pitch" for a general school aid bill in 1962, but in view of the fall elections and the fact that none of the Federal education programs will expire next year, it is "doubtful we will be able to get a general bill."

WILDERNESS BILL HEARINGS GET UNDER WAY IN WEST

Vigorous opposition to the Senate-passed Wilderness bill was expressed by spokesmen for the mining, lumbering and livestock industries and others at the initial western House hearing on the measure October 30 at McCall, Idaho. Presiding was Rep. Gracie Pfost (Dem., Idaho), chairman of the House Interior Subcommittee on Public Lands.

A. J. Teske, secretary of the Idaho Mining Association, stated that his organization opposes the legislation for these reasons: (1) The segregation of substantial areas for single-purpose, nonproductive wilderness use would be "extremely detrimental to the future growth and progress of the basic natural resource economy of Idaho and other western public-land States"; (2) the bill as passed by the Senate permits wide variation of interpretation as to the meaning and intent of its provisions; and (3) the protection of exclusive wilderness use by special statute "is contrary to sound conservation principles and a violation of the multiple-use concept" which has heretofore been declared the policy of Congress.

"It is the considered opinion of the mining industry," Teske declared, "that if the Wilderness bill is enacted into law in its present form, all mineral prospecting will be completely and permanently terminated in an area so vast that it dwarfs all the important producing mining districts in the West. To take such action without first employing every available tool and technique for evaluating the mineral potential would, we believe, be the height of folly, particularly since it is known that most of the areas, including those in Idaho, possess the geologic environment peculiar to mineral deposition."

Mining spokesmen planned to present additional testimony at Subcommittee hearings scheduled at Montrose, Colo., November 1, and at Sacramento, Calif., November 6.

Chairman Pfost has indicated that further hearings will be held before her Subcommittee begins consideration of the measure.

Washington Highlights

TRADE ACT EXTENSION: On agenda of next Congress
WILDERNESS BILL: Western hearings get under way
FUELS STUDY: Preliminary work begun
DEFENSE PLANNING: Assigned to new agency
OIL IMPORTS: House subcommittee begins study
GOLD, SILVER: New Treasury office established
URANIUM: Hearings slated on procurement program
BARTER PROGRAM: Task force recommends expansion
LEAD-ZINC: Study group takes no action at Geneva

COMMITTEE GATHERS DATA FOR NATIONAL FUELS STUDY

With the help of personnel borrowed from the Interior Department, the staff of the Senate Interior Committee is gathering statistics as a basic part of the national fuels study being conducted by the Committee in compliance with a Senate resolution adopted in September.

A Committee aide said that no public hearings are being planned at present but may be held next year in connection with the study, which will cover current and prospective fuel and energy resources of the United States, the probable rates of U. S. fuel and energy consumption in the future, and existing governmental policies and laws affecting the fuels and energy industries. The Committee will then determine what, if any, changes and implementation of policies and laws may be advisable in order to provide an effective national fuels policy.

In conducting the study, the Committee is authorized to expend up to $25,000. Its findings and recommendations are to be submitted to the Senate at the earliest possible date.

NEW AGENCY WILL HANDLE NONMILITARY DEFENSE PLANS

A new Government agency, the Office of Emergency Planning (OEP),

has been created in the Executive Office of the President to handle nonmilitary defense and emergency planning—a function formerly exercised by the now-defunct Office of Civil and Defense Mobilization. Frank B. Ellis, who was OCDM chief, is director of the new agency.

As far as the mining industry is concerned, OEP is just the OCDM under another name. OEP will determine the kinds and quantities of strategic and critical materials to be acquired for the $8 billion stockpile. In the field of mobilization, it will advise the President concerning the utilization of manpower and natural and industrial resources, the stabilization of the civilian economy, and the unification of Federal activities concerned with production, procurement, distribution and transportation of essential supplies.

OEP will also succeed OCDM as the agency which, under the Trade Agreements Act, conducts investigations to determine whether imports of any commodity have risen to a level that threatens to impair the national security. The present Government restrictions on imports of residual oil and other petroleum products were instituted by the President after an investigation of this type.

HOUSE SUBCOMMITTEE PLANS OIL IMPORT PROGRAM STUDY

Comprehensive hearings on the Government's controversial oil import control program will begin November 20 in Washington, Rep. Steed (Dem., Okla.), chairman of a House Small Business Subcommittee, has announced. He said that witnesses scheduled to appear before the Subcommittee will include Government officials, members of State regulatory and conservation agencies, and spokesmen for the coal and oil industries.

Later, Steed said, hearings may be held in other areas of the country if they appear necessary to obtain a complete and accurate record with respect to the oil import program.

TREASURY CREATES OFFICE OF GOLD, SILVER OPERATIONS

Treasury Secretary Dillon has established a new Office of Domestic Gold and Silver Operations, under the supervision of Under Secretary Robert V. Roosa, to exercise the Department's authority with respect to policy decisions affecting these monetary metals. This authority previously was exercised by the Bureau of the Mint.

Director of the new Office is Leland Howard, who had been assistant director of the Bureau of the Mint for several years.

Shortly after this action was taken, Miss Eva B. Adams of Nevada was sworn in as Director of the Bureau of the Mint. Formerly administrative assistant to Senator Bible (Dem., Nev.), Miss Adams had been nominated to this post by the President and confirmed by the Senate just prior to adjournment in September.

URANIUM BUYING PROGRAM IS SUBJECT OF HEARINGS

The Atomic Energy Commission's uranium procurement program, scheduled to expire December 31, 1966, will be the subject of Congressional hearings at Moab, Utah, November 15–16. Purpose of the hearings is to obtain the views of the uranium mining and milling industry as to the problems which will face the industry after that date.

Conducting the hearings will be the Raw Materials Subcommittee of the Joint Atomic Energy Committee. In announcing the hearing, Rep. Aspinall (Dem., Colo.), Subcommittee chairman, said: "Uranium mining and milling have in just a few short years developed into a major industry. The industry was established to provide uranium for the Nation's nuclear weapons program. The weapons requirement is still the most important factor in the uranium market. However, there is no assurance that this requirement will continue indefinitely. In light of these considerations the industry must not be caught short because of inadequate planning."

He added: "From our meetings with the people directly engaged in the uranium industry we hope to be brought up to date on all of the factors affecting the industry today and those which must be faced in the future."

GOVERNMENT CONSIDERS BARTER PROGRAM REVISION

Expansion of the barter program, under which surplus agricultural commodities in Government inventories are exchanged for more durable metals and minerals produced in other countries, may be announced soon by the Department of Agriculture.

The Department is currently evaluating a task force report urging that the program be stepped up under simplified regulations. The task force, appointed by the Secretary of Agriculture earlier this year, was composed of 23 representatives of trade and agriculture who are interested in the program.

In determining what materials should be acquired for the supplemental stockpile, the task force recommended that the Government consider several objectives, including (1) acquisition of materials of which the United States has, or in the future will have, a substantial deficit; (2) removal of surplus materials from world markets without increasing productive capacity; (3) increasing or maintaining employment in distressed areas of the United States through use of domestic processing facilities; and (4) assistance in keeping the U. S. domestic mobilization base of vital strategic industries in a healthy condition.

The barter program was initiated in 1949. Acquisitions of strategic materials up to July 1, 1961, totaled $1.4 billion; in the past fiscal year the total was $165.2 million. Wheat and cotton constituted the bulk of the surplus farm commodities involved.

LEAD-ZINC STUDY GROUP MEETS, TAKES NO ACTION

No new action is necessary to correct the present world oversupply situation in lead or zinc, the International Lead-Zinc Study Group decided at a meeting in Geneva, Switzerland, last month. The United States is one of the 24 producing and consuming nations which participated in the session.

It was announced that some member countries agreed to continue present restrictions on both mine and metal production of lead during the first quarter of next year. As to zinc, the announcement stated, "it was expected that there would be approximate balance between new supplies and consumption of zinc in the first half of 1962."

The Group said it would meet again prior to March 31, 1962 to review the situation.

"It's a salted mine, all right."

personals

Charles M. Brinkerhoff, president of the Anaconda Co., has been awarded Columbia University's Egleston medal for distinguished engineering achievement. The medal has been awarded annually since 1939 in memory of Thomas Egleston, who founded the first school of mines in the United States at Columbia in 1864 and headed the school until 1897.

Brinkerhoff has been in the copper industry for 36 years, beginning as a cost engineer at Morenci, Ariz., for Phelps Dodge Corp. He was subsequently with Inspiration Consolidated Copper Co. for nine years, leaving in 1935 to join Andes Copper Mining Co. in Chile. He spent the following 20 years in various managerial posts and in 1956 became executive vice president of Andes and Chile Exploration Co. Since 1958, Brinkerhoff has been president of Anaconda.

Paul Morton, president of Cannelton Coal Co., has been reelected president of the Kanawha Coal Operators Association. Other officers reelected include vice president **C. O. Kane,** manager of mines, Armco Steel Corp., treasurer **L. Newton Thomas,** president, Carbon Fuel Co., and executive secretary **Quinn Morton III.**

W. W. Walker, president of Majestic Collieries Co. and Ashland Mining Corp. and chairman of Clintwood Mining Co. and Harman Mining Corp., has been elected president of the Smokeless Operators Association at Bluefield, W. Va. Elected first vice president was **W. A. Haslam,** president, Winding Gulf Coals, Inc., while the post of second vice president went to **P. P. Ferretti,** president, Pocahontas Fuel Co., division of Consolidated Coal Co. **Albert S. Kemper, Jr.,** president of Premier Pocahontas Co., was elected treasurer and **J. B. Wooldridge** continues as secretary.

Francis Cameron, president of St. Joseph Lead Co., has been elected a director of Magma Copper Co. and its subsidiary, San Manuel Copper Corp. He fills the vacancies on both boards created by the death of Arthur Notman.

Richard C. Wells and **Thomas R. Vaughan** have been elected directors of Freeport Sulphur Co. Wells is executive vice president of the company and chairman of National Potash Co., which Freeport owns jointly with Consolidation Coal Co. He joined Freeport in 1939 and has been executive vice president since 1959. Vaughan is vice president and general counsel and has been with Freeport for 19 years. He was named general counsel for the company last year. Other personnel changes in the company include the election of **Peter Black** and **Arthur W. Gilbart** to vice presidencies, and **Wilmer H. Kingsford** to assistant vice president.

Charles D. Michaelson has been appointed vice president, mining, and **Gordon B. Russell,** treasurer and comptroller, of Kennecott Copper Corp. Michaelson has been general manager of Kennecott's Western

C. D. Michaelson

G. B. Russell

Mining Divisions for the past six years. Prior to that he was vice president and director of Braden Copper Co., Chilean subsidiary of Kennecott. He has served in the mining industry for 29 years in various capacities in the United States, Cuba, Mexico, Bolivia and Chile.

Russell has been with Kennecott for 20 years and has been comptroller for the past nine years.

Succeeding Michaelson as general manager of the Western Mining Divisions is **John C. Kinnear, Jr.,** who for the past 11 years has been general

J. C. Kinnear, Jr.

M. J. O'Shaughnessy

manager of the company's Nevada Mines Division. He has been with Kennecott for 23 years. **M. J. O'Shaughnessy,** assistant to Kinnear since 1955, was named general manager of the Nevada Mines Division.

Three executive appointments have been announced by Callahan Mining Corp. **E. Arthur Salo,** formerly secretary-treasurer was elected vice president; **Frank S. Micari,** assistant treasurer, was named treasurer; and **Sam Harris,** a Callahan director and partner in Strasser, Spiegelberg, Fried and Frank, which serves as the company's general counsel, was appointed corporate secretary.

E. Arthur Salo

Charles R. Cox, retired president of Kennecott Copper Corp., has been elected a director of Firth Sterling Inc. He will serve the company part-time as a consultant.

Victor G. Aubry, Jr., was recently promoted to vice president and general manager of Houdaille Construction Materials, Inc. He succeeds **Harry Haas,** recently elected president and general manager of Duval-Wright Engineering Co., a Houdaille subsidiary.

William R. Lewis has been appointed a vice president of Union Carbide Ore Co., division of Union Carbide Corp. Lewis joined Union

Carbide in 1941 and has been with Union Carbide Ore Co. since 1959.

George E. Kruger, vice president and technical director, mining industry, of the Chase Manhattan Bank, has been elected a director of Inspiration Consolidated Copper Co. He will fill the vacancy caused by the recent death of Leon H. Johnston.

W. A. Starkovich, safety director for Phillips Petroleum Co. at Grants, N. M., has been elected president of the Uranium Operators Safety Council. He succeeds **H. J. Abbiss,** safety director, Homestake-Sapin Partners. The Council, organized in 1960, has as its objective the reduction of accidents in mines of the Ambrosia Lake district.

Harry G. Gerber has joined Marcona Mining Co. He was previously general superintendent of Canadian Mining Operations, Pickands Mather & Co.

J. S. Mitchell, who has been plant superintendent for Southwest Potash Co. at Carlsbad, N. M., was recently appointed general manager of the company's new nitrate of potash plant under construction at Vicksburg, Miss. **J. M. Downey,** with Southwest Potash since 1952, has been named general superintendent at Vicksburg.

K. K. Kincell, who is general superintendent of Mountaineer Coal Co., division of Consolidation Coal Co. at Fairmont, W. Va., is one of 53 business executives from 10 countries participating in an eight-week course entitled Management Problems for Executives at the University of Pittsburgh.

Rodger H. Chapman has joined the staff of the California State Division of Mines and Geology. Chapman, a geophysicist, will inaugurate a new program in geophysics for the department. He was formerly senior exploration geologist with Columbia-Geneva Division of U. S. Steel Corp.

D. D. Turberville was recently appointed superintendent of Dysart No. 2 mine of Sabre-Pinion Corp. at Ambrosia Lake, N. M. Turberville was formerly assistant superintendent and succeeds **Harold Powers,** who was general superintendent for Hidden Splendor Mining Co. Hidden Splendor recently sold its interest in Dysart No. 2 to Sabre-Pinion.

John B. Hollister, Jr., has been named assistant manager, ore sales-general, Cleveland-Cliffs Iron Co. At the same time, **Alexander McAfee** was designated assistant manager, ore sales—Lake Superior. Hollister has been with Cleveland-Cliffs for 10 years, all in ore sales, and McAfee, has been in the Ore Sales Department since beginning with the company in 1950.

Frank J. Downey, formerly smelter superintendent for American Smelting & Refining Co. at Hayden, Ariz., has joined White Pine Copper Co. as smelter superintendent at White Pine, Mich.

Robert F. May, formerly valuation engineer for the Bureau of Land Management, has joined the staff of the U. S. Forest Service's Central States Forest Experimental Station at Berea, Ky., where he will conduct research in protecting and restoring forest resources on strip and auger-mined land. May spent five years with the Bureau of Land Management, coming to it from Pend Oreille Mines & Metals Co. at Metaline Fall, Wash.

William LeClair, superintendent of the Cleveland-Cliffs Iron Co. Hawkins mine at Nashwauk, Minn., has been transferred to the company's Canisteo mine at Coleraine as superintendent. **Melvin Viant** succeeds him at the Hawkins. **Ronald Pearson,** formerly superintendent at the Canisteo, has become superintendent of the Hill-Trumbull mine at Marble and the Holman-Cliffs mine at Taconite.

Langan W. Swent, general manager for Homestake-Sapin Partners at Grants, N. M., has been elected president of the New Mexico Mining Association. At the same time **J. W. Faust,** vice president and general manager, American-Peru Mining Co., was elected first vice president and **J. E. Tong,** resident manager, Duval Sulphur & Potash Co., became second vice president.

OBITUARIES

Charles F. Ayer, 97, honorary board chairman of the Newmont Mining Corp., died in New Rochelle, N. Y., on September 23. Mr. Ayer was a former president of Newmont and had been a director of Texas Gulf Sulphur Co. and president of the Magma Copper Co. during his career in the mining industry. From 1947 to 1953 he was chairman of Newmont. At the time of his death he held directorships in Newmont and in the Hudson Bay Mining & Smelting Co. Ltd.

George H. Crosby, 96, pioneer explorer and promoter on the Mesabi and Cuyuna iron ore ranges, died in Duluth, Minn., September 21.

Mr. Crosby traveled the Mesabi iron range in the 1890's before railroads penetrated the area and with others discovered the Hawkins, Crosby, and La Rue mines in the Nashwauk district and the Morton mine near Hibbing. He later led exploration parties to the Cuyuna range, where the town of Crosby was named for him, and helped in the exploration and discovery of mining properties there.

Fred W. Whiteside, 85, charter member and secretary-treasurer of the Rocky Mountain Coal Mining Institute for 40 years, died in Denver September 10. In former years Mr. Whiteside was a member of the State Board of Coal Mine Officials and an engineer for the Denver & Rio Grande Railroad, Colorado Fuel & Iron Corp., and Victor-American Fuel Co.

R. F. Mahoney, 54, vice president and a director of Callahan Mining Corp., died October 10 after a long illness. Mr. Mahoney joined Callahan as vice president in 1946 and was elected a director of the company in the same year. Before that he had been superintendent of the Sunshine Mining Co. for seven years.

Robert Bailey, 64, president of Bailey Coal Co., died at Philipsburg, Pa., September 24, as a result of injuries suffered in an automobile collision.

Charles S. Gunter, 79, founder and president of English Mica Co., died at Spruce Pine, N. C., September 21.

Chester H. Sanderson, advertising manager for Mine Safety Appliances Co., for the past 12 years, died in Penn Hills, Pa., October 1. He was 54, and had been with Mine Safety for 34 years.

Jerome R. George, Jr., chairman of the board of directors of Coppus Engineering Corp., died October 6, in Worcester, Mass.

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Mack M Model for

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A year ago two new Mack M Models—a 45-ton six wheeler and 30-ton four wheeler—made their debut to receive an immediate acceptance unprecedented in off-highway operations. Now four additional M's are ready to take their place alongside the trailblazing two—a 15, 18, and 25-ton four wheeler and a 30-ton six wheeler. This pacesetting line of heavy-duty rear dumpers and tractors introduces a new dimension in profitable and practical off-highway hauling.

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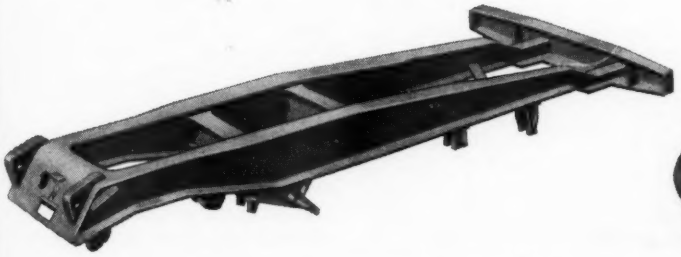
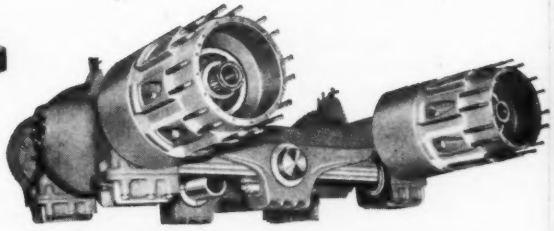
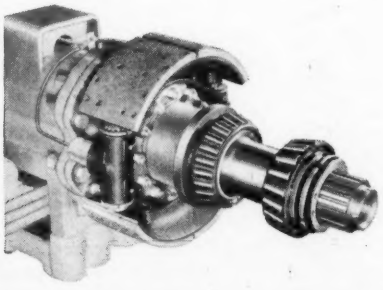


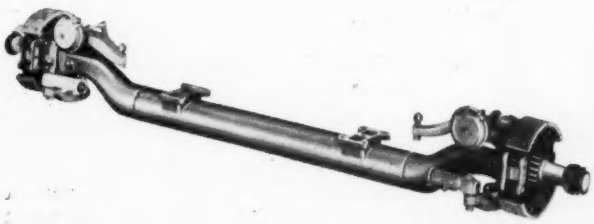
A NEW DIMENSION IN FRAME STRENGTH—Built to shrug off jarring shovel drops, the extra solid, extra strong five-crossmember frame of the M30X Mack is typical of the engineering advances in all M Models. Welded crossmembers, including integral front and rear bumpers, tie alloy steel fabricated I-beam main rails together.



A NEW DIMENSION IN BOGIE PERFORMANCE—Indicative of advances in all Mack M Models, this newly designed heavy-duty twin-axle bogie on six-wheeler M45SX offers the strength and simplicity of straight-through drive and single-reduction carriers with Mack Planidrive reduction at the hubs. Unusual bogie flexibility results in exceptionally long tire life, reduces frame twist and wracking and keeps all wheels equally loaded. Suspension is through walking beam and flat leaf springs.



A NEW DIMENSION IN BRAKING SURENESS—Safe, sure braking power for maximum control at all times is another feature of all M Model Macks. Illustrated here is the air hydraulic rear braking assembly for the M30X and M45SX. Front brakes are air; rear are air hydraulic with separate master cylinders for extra safety factor.



A NEW DIMENSION IN FRONT AXLE LOADING—The new tubular front axle, featuring steel tubing seven inches in diameter with walls ¾" thick, provides a reversed-elliot front axle for the M45SX and M30X that easily withstands the additional loading made possible by Mack's new forward cab location.

NEWS and views

Coal Pulverization Research Contract Awarded by OCR

A $142,900 contract has been granted to Bituminous Coal Research by the Office of Coal Research to study the preparation, transportation, and utilization of superfine pulverized coal. The purpose of the contract, the second awarded by the newly formed Office of Coal Research, is to investigate for the first time the technology of superfine pulverized coal.

The objectives are to develop systems for: (1) preparing pulverized coal with the removal of sulphur and ash content; (2) devising continuous transportation systems from mine to factory; and (3) designing and operating boilers to burn superfine coal efficiently in continuous sequence with transportation systems. The study is expected to take approximately two years.

Other work under the contract also calls for study of superfine coal as a raw material in gasification, carbonization, and similar methods.

Evaluation of transportation methods will include pressure and vacuum handling; liquid handling with water and other mediums; and equipment, capacity, and handling methods by rail and truck transport. Research on utilization will include testing combustion of various types of pulverized coal to determine energy and material balances.

National First Aid and Mine Rescue Contest

Teams from West Virginia and Kentucky took top honors at the National First-Aid and Mine Rescue Contest in Charleston, W. Va., October 2, 3, & 4, after the closest competition in 50 years. For the first time on record a team repeated as winner in the first-aid meet. Duplicating its 1959 performance, the Compass No. 1 team of Clinchfield Coal Co., Clarksburg, W. Va., outscored more than 40 other teams to take the 1961 first-aid championship with 99.48 points. In 1959 the team scored 99.5. Hanna Coal Co., Division of Consolidation Coal Co., had three teams among the top six first-aid winners.

Island Creek Coal Company's Holden, W. Va., Division team won the combination first-aid and mine rescue contest, and placed third in the mine rescue competition. Holden won the combination event by two points over the Frick District team of U. S. Steel Corp., Uniontown, Pa., after an unprecedented tie for first place was broken on the 11th problem. The Frick team was awarded second place, while U. S. Steel's No. 3 team, Gary, W. Va., was third.

First honors in the mine rescue contest among 11 teams went to Inland Steel Company's No. 1 team, Wheelwright, Ky. International Harvester Company's No. 1 team, Benham, Ky., was second.

Other first-aid prize winners were: 2nd, Ireland No. 8 mine, Hanna Coal Co., Division of Consolidation Coal Co., Moundsville, W. Va.; 3rd, Turner Elkhorn Mining Co., Drift, Ky.; 4th, Harewood Mine No. 1 team, Allied Chemical Corp., Semet-Solvay Division, Longacre, W. Va.; 5th and 6th, respectively, Georgetown Preparation Plant and Pine Fork No. 15 mine teams, Hanna Coal Co., Division of Consolidation Coal Co., Cadiz, Ohio.

Coal Injected into Blast Furnaces

Koopers Co., Inc., has entered into an agreement with Bituminous Coal Research, Inc., which gives Koppers exclusive rights to a device and related techniques to be applied to metallurgical furnaces for the controlled introduction of solids into a stream of air against substantial pressures. Koppers plans first to apply this method, which includes a device called a "coal pump," to the injection of coal into blast furnaces. The coal pump was developed by the locomotive development program of Bituminous Coal Research, Inc., in their work on coal fired gas turbines.

Bituminous Coal will make available to Koppers the findings resulting from about 12 years of intensive research on this application. In addition, the two organizations are conducting development programs on specific applications to enable Koppers to present to industry a highly perfected installation for immediate full-scale application.

The injection of coal into blast furnaces to replace a substantial part of the normal coke fuel will be of great economic benefit to this metallurgical process in many areas. In some cases, this injected coal will replace natural gas or fuel oil, both of which have been used commercially. Additional favorable results expected from this process are: benefits to operation accruing from hydrogen released by the coal in the combustion zone, and the more complete utilization of blast furnace gas by the use of higher stove heats.

New Strip Mining Law Passed in Pennsylvania

Pennsylvania has enacted a new strip mining law to become effective January 1, 1962. The provisions of the law for the bituminous fields are as follows: On all productive land and in built-up areas, strip pits must be backfilled at a slant of 45° from the bottom of the excavation to the highwall of the cut. Productive land

is defined as that which has produced farm crops within five previous years. When pits extend to highways, public buildings, churches or community buildings, backfills must be restored to the original contour within 100 ft.

For any remaining distance up to 750 ft, there must be a 45° backfill. In nonproductive areas—such as woodlands and wilderness—operators must backfill at an angle of 70° to the top of the highest cliff and the bottom of the pit must be covered with five ft of earth.

Anthracite fields are regulated as follows: On mining operations less than 75 ft deep, the pit must be backfilled to the highwall at a 45° angle within 700 ft of roads and built-up areas. No backfilling, except for a five-ft earth cover over the exposed coal vein, will be required in excavations more than 75 ft deep. (Most strip mining in the eastern anthracite regions extends below 75 ft).

Bond requirements for all strip mine operators are increased to $400 an acre or a minimum of $4000 to assure their compliance with restoration laws. Under the old regulations, open pits had to be backfilled only three ft at the bottom to prevent water and coal from forming acid and polluting streams. Mining operations within 75 ft of highways or within 200 ft of occupied dwellings had to be restored to their original contour, and bond requirements were set at $300 an acre, with $3000 minimum.

Bethlehem Mines Get Safety Awards

Five operations of Bethlehem Mines Corp., Bethlehem Steel's mining subsidiary, have received awards from the National Safety Council for important safety achievements during 1960.

Included were the Award of Honor, highest in the power of the Safety Council to bestow; the Award of Merit, second highest honor; and the Certificate of Commendation, third highest honor.

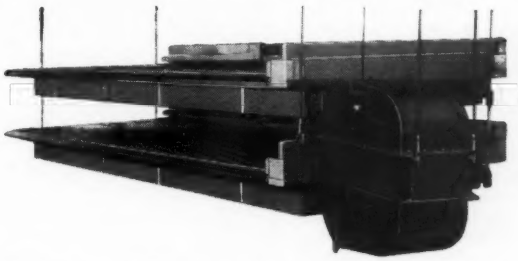
Recipients of the Award of Honor were Mine No. 58 at Marianna, Pa., Mine No. 51, at Ellsworth, Pa., and the Elkhorn Division at Jenkins, Ky. The award of Merit went to Mine No. 101 at Century, W. Va., and Mine No. 74 at Johnstown. The corporation's chemical laboratory at Johnstown received the Certificate of Commendation.

Mine No. 58 finished the calendar year 1960 with a perfect score of no disabling injuries. This mine worked 1,676,703 man-hours from November 6, 1958, to December 31, 1960, without a disabling injury.

Mine No. 51 finished 1960 with a frequency of 5.17, showing a marked reduction in frequency and severity of disabling injuries as compared with its past record and with other coal mines of the Nation.

The Elkhorn Division concluded the calendar year 1960 with a frequency rate of 3.88, also an outstanding performance in the reduction of frequency and severity rates in 1960 over past years.

The record for which the Johnstown chemical laboratory received the Certificate of Commendation covers from 1919 to December 31, 1960. During this time, under the direction of Chester Watts, chief chemist, retired, the laboratory worked a total of 634,992 man-hours without a single disabling injury. Watts directed the laboratory and its activities without interruption through the 42 years.



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And it is easy to visualize the economies made possible by halving of the service connections such as piping, wiring and laundering.

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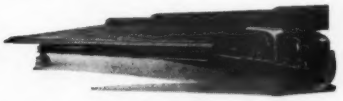

Where its use may be indicated, the SuperDuty DIAGONAL-DECK® Table continues to offer the same highly efficient and economical preparation of fine sizes. Special models are available in this single deck equipment also for handling high refuse feeds. For full information, simply ask for Bulletin 119.

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ALSO . . .

M. A. Hanna Co. directors have proposed a plan for disposal of mining, shipping and other operating activities and transformation of the industrial complex into a large closed-end investment company. Assets of the proposed investment company would amount to about $500,000,000, consisting largely of securities and cash, about 70 percent of which would be concentrated in the stocks of three companies, National Steel Corp., Consolidation Coal Co., and The Hanna Mining Co.

Under the proposed plan, Gilbert W. Humphrey, president, would become chairman. He is the son of George M. Humphrey, former Secretary of the Treasury and president of the M. A. Hanna Co. from 1929 to 1950. Joseph H. Thompson, vice chairman, would become chairman of the executive committee. William A. Hobbs, chief financial officer, would become president and treasurer, and Richard B. Ainsworth, a Cleveland attorney, would be secretary.

Norfolk & Western Railway has announced that it will double the capacity of the coal pier under construction at Lambert's Point in Norfolk. The expansion will boost the maximum dumping rate of the pier from 10,000 to 20,000 tph. The average or continuous rating will be increased from 8000 to 16,000 tph.

The N&W also announced an order for 1000 85-ton coal hopper cars. The cars ordered will bring N&W's ownership of this new type of equipment to 3000 units. Replacing 70-ton cars, these new cars will increase delivery and unloading service and lower maintenance costs.

Bethlehem Steel Co. has recently patented a new method that enables certain wet iron ores containing as much as 15 percent of water to be economically used in steelmaking. This is accomplished by mixing the wet ore with a proper amount of dry flue dust or coke or sinter particles to dry the ore to a water content of no more than 7½ percent.

In another area Bethlehem has patented a shaft-type furnace into which moist balls, or pellets, of concentrated iron ore are introduced at the top. The pellets descend through the shaft of the furnace in which they are heated by hot gases from a separate fuel combustion chamber at about 2300°F. The pellets then descend into another chamber in which they are cooled by a continuous current of air to about 220°, at which temperature they can be handled.

St. Lawrence Columbium & Metals Corp. has made its first tonnage shipment of 53 percent columbium concentrates to a major producer of ferro-columbium and columbium alloys at Niagara Falls, N. Y. The new mill, which went into pilot production in September, is now running at about 60 percent of rated capacity. This is 500 tons of ore per day.

U. S. Steel announced that their new iron ore beneficiation plant, located at Oliver's Sherman mine near Buhl on the Mesabi Range, is now in operation. The new facility, which is known as the Sherman concentrator, primarily will process low-grade ores produced in Oliver's nearby Monroe and Sherman mines. The plant will operate in conjunction with the previously built ore crushing and sizing facilities. It will be Minnesota's eightieth ore beneficiation plant.

The new mill is designed to wash and scrub iron ores, process them through heavy media concentrating units and treat them in cyclone and spiral concentrating equipment.

The Canadian ore carrier Ralph S. Misener has delivered 11,044 tons of pellets to Youngstown Sheet & Tube Company's Chicago plant. This is a preliminary shipment, the only one coming into the Lakes this year from a vast new source of iron ore in the Wabush Lake area of northern Canada. Wabush Iron Co., Ltd., is a $200,000,000 project, managed by Pickands Mather & Co. of Cleveland. Normal production is scheduled for 1965.

Republic Steel Corp. has announced the reopening of the company's Newfield coal mine at Verona, Pa. The mine, idle since July 1960, employs approximately 200 men.

New York Trap Rock Corp. has announced the acquisition of the assets of Gotham Sand & Stone Corp.

Gotham Sand, a Long Island stevedoring and trucking firm has leaseholds on four docks along the North Shore of the Island, barge unloading equipment and a large fleet of trucks serving the construction industry in Nassau and Suffolk counties. Trap Rock, in acquiring these facilities, will be in a position to expand its service to its established customers, insuring deliveries by water, truck and rail to all points on Long Island, which, together with stockpiles at strategic points, will make supplies of stone products available at all times of the year.

Consolidated Aluminum Co. has acquired a site at Johnsville, Tenn., which is suitable for a primary aluminum reduction plant. The site, about 235 acres, was purchased from TVA. The company plans to enter the primary aluminum producing field (it already produces high purity metal) as soon as feasible, thus becoming the seventh domestic company to produce standard ingot. Tentative plans, pending new developments, call for starting construction of a reduction plant late this fall.

The Turkish government will act as host for a Central Treaty Organization Coal Symposium to be held at Zonguldak, Turkey and other mining centers between November 30 and December 14, 1961. Turkey, Iran, Pakistan, the United Kingdom, and the United States will offer a series of comprehensive papers and discussions covering the economics of coal production, mining problems, and the geology of coal mining. Participation by CENTO country delegates is being financed by the United States through the Office of the U. S. Economic Coordinator for CENTO Affairs. A number of commercial firms are also expected to send observers to the symposium. Papers are invited to be presented at the symposium by observers as well as delegates.

Rapidly growing demand for copper with enhanced electrical conductivity has resulted in a decision by American Metal Climax, Inc., to double U. S. capacity for the production of oxygen-free high-conductivity copper. The company will invest $1,755,000 for the construction of new melting, casting and handling facilities at the U. S. Metals Refining Co., Carteret, N. J., subsidiary.

A major expansion of its Groveland, Mich., iron ore concentrating plant, including facilities to produce pellets made of ore is planned by the Hanna Mining Co. Annual capacity of the Groveland plant will be increased to 1,250,000 tons. The estimated cost of the expansion project will be more than $10,000,000.

Groveland, on the Menominee Range near Iron Mountain, produces a high grade iron ore concentrate from jasper, a low grade iron bearing rock. Last year the plant, which was completed in 1958, produced 670,000 tons of concentrates. Employment at the plant and mine is expected to increase after the expansion to about 250 from the 180 now working there.

A new brattice material, a lightweight brick has been developed by the Council for Scientific and Industrial Research,* Pretoria, in collaboration with the Anglo American Corp. It has been designed for the construction of ventilation sealing walls in the stoping areas of mines where the rock ceiling descends slowly over a long period.

Walls made of these bricks can withstand a fall in the roof of as much as 50 percent without collapsing as would be the case if ordinary building bricks or concrete blocks were used. The new compressible bricks are made of exfoliated vermiculite, the particles are bonded together with bitumen.

* *As taken from the South African Mining & Engineering Journal, August 4, 1961, p. 259.*

Get DOUBLE EXPANSION for DEPENDABLE roof support with PATTIN roof bolts and expansion shells

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Pattin expansion shells are available and serviced exclusively by Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies should contact them direct for information and consultation.

The PATTIN split-type BOLT

The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

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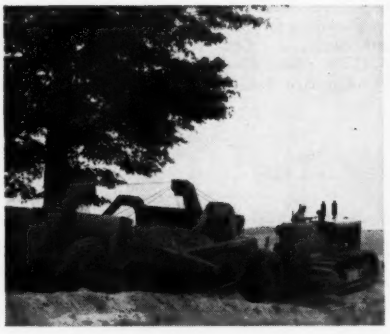
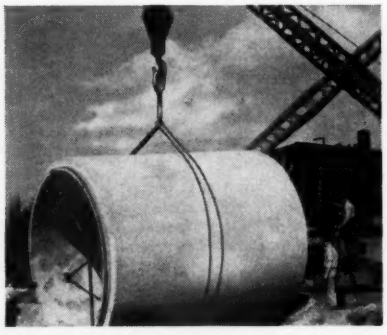
Old sheaves may never die, but in "fading away" they develop conditions which shorten rope life. Sheaves with grooves corrugated with rope lay impressions should be replaced with new ones before new wire rope is installed.

Union Tuffy's on these jobs give you the ultimate low cost.



Tuffy Scraper Rope

Flexible enough to take sharp bends; stiff enough to resist looping and kinking when slack; highly resistant to the shock of load impact — that's Tuffy balanced construction. Mount a reel on your scraper—save wasting sound rope.



Tuffy Slings and Hoist Lines

Slings are a patented, 9-part machine-braided wire fabric that is next to impossible to knot or kink. Hoist lines have built-in strength, toughness, flexibility. Balanced—a top-performing team for handling every type of material. In addition to Tuffy, Union Wire Rope furnishes a complete line of slings.

Tuffy Dozer Rope

Mounts right on your dozer in a 150′ reel. When rope shows wear, just feed through enough to replace the damaged part. Saves rope, gives you a bonus of extra service. Also available in 300′ and 500′ reels.

The Union Wire Rope Organization Gives You . . . RIGHT-NOW service with the RIGHT rope. Get set for quick action. Vast Union Wire Rope facilities assure fast delivery of just the wire rope or sling you need. More than 1600 standard constructions are available *plus* the famous Tuffy family of ropes and slings tailored to special needs. Hundreds of distributors and 15 strategically located warehouses help you meet emergencies—cut wasteful down-time. Call your Union distributor. He's listed in the phone book Yellow Pages.

Tuffy® Tips

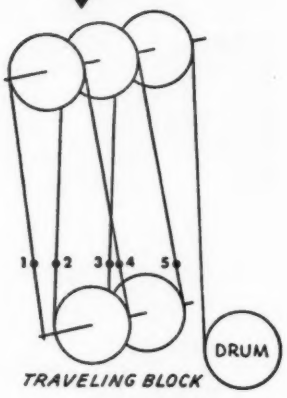
and keeps going longer if not abused

New steels are born at Armco

Diameter of Rope	Min. Dia.	Max. Dia.
¼ - 5/16	+ 1/64"	+ 1/32"
3/8 - ¾	+ 1/32"	+ 1/16"
7/8 - 1⅛	+ 3/16"	+ 3/32"
1¼ - 1½	+ 1/16"	+ ⅛"
1⅝ - 2¼	+ 3/32"	+ 3/16"
2⅜ and larger	+ ⅛"	+ ¼"

Recommended groove sizes:

New ropes are usually over-size. It is advisable to have groove diameters of sheaves or drums as large as the actual calipered diameter of the new rope, or slightly larger. We recommend sizes as (above) charted.

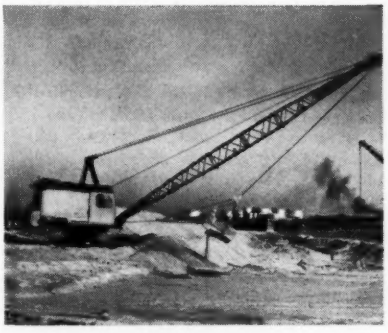


How to Figure Reeving Loads

Reeving ropes through the sheaves multiplies the number of parts supporting the load. The lead line to the drum carries the weight of the load lifted, divided by the number of parts, plus the accumulation of friction on all sheaves.

To count the number of parts supporting the load, draw an imaginary line across the parts of the rope supporting the load.

The efficiency of reeving systems ranging from one to eight parts is shown in charts which Union Wire Rope engineers make available to users.

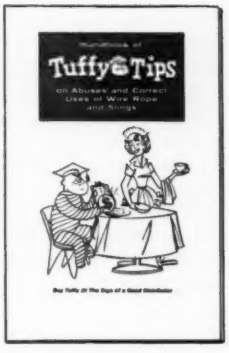


Tuffy Dragline Rope

High abrasive resistance and super flexibility. Gives long service, dependable action in handling any material—wet or dry dirt, sand, gravel, rock, minerals. Rides smoothly on grooves—hugs the drum when casting for full load.

Union's Handbook of TUFFY TIPS—Free!

The "Tuffy Tips" shown here are quoted right out of Union Wire Rope's handbook. In it there are dozens of other priceless hints on the correct use of wire rope. The common abuses and how to avoid them. How to save costly injuries. Maintenance tips. The proper fittings and how to apply them. Recommended sizes. Many other facts and suggestions that will cut down your rope costs and help you get out of wire rope the full service we build into it. No charge. Write Union Wire Rope, Armco Steel Corporation, 2144 Manchester Avenue, Kansas City 26, Missouri.



4-61

ARMCO Union Wire Rope

MiNE-POWER

by Steve Bunish

whose many years of practical experience underground followed by developmental work at Anaconda have made him a recognized authority on mining cables.

Steve Bunish answers your questions on mine cable application and maintenance.

#3: how to minimize bulk and current leakage in A. C. cable splices

Dear Steve,

We have converted one section of our mine to A.C. power. It's taking us a little time to get used to the more complex A.C. shuttle car cables, especially making splices. The A.C. splices are bulky, and we have run into some difficulty with leakage, which trips the circuit in wet areas. Any suggestions to remedy this problem?

L. D. W., Kentucky

Dear L. D. W.,

The best possible cable maintenance is necessary if you want to take full advantage of the efficiency and safety of A.C. systems. Whenever you splice a cable, you are, in effect, rebuilding the cable by hand. The following suggestions will help decrease the outside dimensions of splices and reduce the leakage problem.

1. Stagger all the joints in a splice. Connectors build up the outside diameter of the conductor considerably. Spreading the joints over a longer distance along the cable not only reduces the size of the splice, but also helps prevent the conductors from chafing the insulating tapes, which can occur when connectors are directly opposite one another. This should help the leakage problem, too. A good rule of thumb is to space out the joints in the conductors so that each joint is always opposite the original insulation of the adjacent conductors.

2. Scarf or pencil down the insulation at the joint before applying the insulating tape. This helps provide a clean surface for bonding the insulating tape, and a gradual slope for building up the insulation.

It's a good idea to have a spare cable on hand for a change-out on an off shift, so that all repairs can be made properly and permanently.

One good way to lick mine cable problems before they start is to buy cable specifically designed for the job. Anaconda makes a complete line of job-tailored cables for every mining operation.

61300

Steve Bunish will be glad to answer your minepower problem. Simply write it up and send it to "Minepower," c/o Steve Bunish, Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

See the man from ANACONDA® for Mining Cables

THE REPORT CORNER

Recent Publications of Interest to Mining Men

USBM RI 5751. "Experimental Treatment of Nevada and California Fluorspar Ores," by A. L. Engel and H. J. Heinen.*

USBM RI 5776. "Electric Smelting Titaniferous Magnetite Ore, Iron Mountain, Wyo.," by H. C. Fuller and V. E. Edlund.*

USBM RI 5783. "Radiochemical Precipitation Studies of Rare-Earth Oxalates," by Kenneth G. Broadhead and Howard H. Heady.*

USBM RI 5803. "Performance of a Gas-Synthesis Demonstration Plant for Producing Liquid Fuels from Coal," by R. G. Dressler and L. L. Hirst.*

USBM RI 5818. "Preparation Characteristics of Coal from Harrison County, W. Va.," by T. E. Gray and E. R. Palowitch.*

USBM IC 8043. "Recent Developments in Fire-Resistant Hydraulic Fluids for Underground Use," by Samuel P. Polack, Allan F. Smith, and Henry P. Barthe.*

***Available from Publications Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.**

USGS Bulletin 1084-I. "A Spectrochemical Method for the Semiquantitative Analysis of Rocks Minerals, and Ores," by A. T. Myers, R. G. Havens, and P. J. Dunton.** Price 15 cents (paper cover)

USGS Bulletin 1146-A. "Geophysical Abstracts 184 January-March 1961," by James W. Clarke, Dorothy B. Vitaliano, Virginia S. Neuschel, and others.** Price 40 cents (single copy)

****For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.**

Electrostatic Separation of Coals, (Translated from Polish), by J. Krajewski and S. Herszderfer. Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Price: 50 cents.

Circular 311. Strippable Coal Reserves of Illinois—Part 3—Madison, Macoupin, Jersey, Greene, Scott, Morgan and Cass Counties by William H. Smith. Illinois State Geological Survey, Urbana.

Geologic Map of Washington. Scale: 1:500,000. Size: 51 × 76 in. Over 100 different rock types shown are explained in legend. Available either rolled or folded. Department of Conservation, 335 General Administration Bldg., Olympia, Wash. Price: $3.00.

1962 AMC Coal Convention

Industry Committee Planning Another Outstanding Program

L. H. Chalfant

PITTSBURGH will be the scene of the 1962 Coal Convention of the American Mining Congress next May 6–9. Coal mining men from all parts of the nation will gather in the steel and coal capital of the world to discuss all facets of mining technology and consider economic factors affecting the industry.

Under the chairmanship of L. H. Chalfant, manager, Bethlehem Mines Corp., the Program Committee will meet shortly to select subjects for discussion at the Convention and speakers to make the presentations. Made up of a wide cross-section of the coal industry—including operators all of the large coal fields, representing both deep and strip mining, together with representatives of mine equipment manufacturers—the committee is responsible for putting together a program that will bring the industry abreast of general economic problems and all phases of coal mining, preparation and safety.

The yearly Coal Conventions of the American Mining Congress have charted the coal industry's progress in technology over the years, and the 1962 Convention will continue this worthy tradition. Progressive mining men have already made plans to be in Pittsburgh next May 6–9. They know it will pay off!

— Members of Program Committee—1962 Coal Convention —

L. H. Chalfant (*Chairman*), Bethlehem Mines Corp.
Ralph E. Bailey, Peabody Coal Co.
Clayton G. Ball, Paul Weir Co.
William Benzon, Bethlehem Mines Corp.
A. P. Boxley, Eastern Gas and Fuel Associates
Cletus A. Broecker, Ayrshire Collieries Corp.
J. E. Brown, Jr., Southern Electric Generating Co.
A. F. Busick, Jr., Marion Power Shovel Co.
George Cady, Mining Equipment Division, Columbus McKinnon Corp.
Paul Callis, Tenessee Consolidated Coal Co.
S. M. Cassidy, Consolidation Coal Co.
H. B. Charmbury, Pennsylvania State University
Jesse F. Core, U. S. Steel Corp.
C. C. Cornelius, Emerald Coal & Coke Co.
D. E. Davidson, Link-Belt Co.
H. G. Dillon, Lee-Norse Corp.
W. W. Dukes, Stonefort Coal Mining Co.
E. F. Eckhardt, Central Ohio Coal Co.
Charles B. Elledge, General Electric Co.
L. D. Ellison, Island Creek Coal Co.
W. Stuart Emmons, Hulbert Oil & Grease Co.
J. S. Gelston, West Penn Power Co.
Austin Goodyear, Hewitt-Robins Incorporated
R. G. Greer, International Harvester Co.
D. N. Griffin, Deister Concentrator Co.
J. L. Hamilton, Island Creek Coal Co.
R. B. Hazard, Raybestos-Manhattan, Inc.
Robert G. Heers, Kaiser Steel Corp.
R. J. Hepburn, The United Electric Coal Companies
William E. Hess, Jones & Laughlin Steel Corp.
R. H. Jamison, Jr., Delmont Fuel Co.
George L. Judy, Christopher Coal Co.
Arnold E. Lamm, Pittsburg & Midway Coal Mining Co.
H. F. Lawrence, The W. S. Tyler Co.
J. B. Long, The Long-Airdox Co.
J. Richard Lucas, Virginia Polytechnic Institute
Gordon MacVean, National Mine Service, Inc.
H. E. Mauck, Freeman Coal Mining Corp.
J. L. McQuade, Maust Coal & Coke Corp.
P. H. Mulcahy, Western Machinery Co.
C. R. Nailler, Consolidation Coal Co.
C. Lynn Peterson, Peterson Filters & Engineering Co.
Edwin R. Phelps, Peabody Coal Co.
B. R. Putnam, Jr., American Cyanamid Co.
James D. Reilly, Hanna Coal Co.
J. J. Reilly, Jones & Laughlin Steel Corp.
C. E. Richardson, Bird Coal Co.
William J. Rude, Glen Alden Coal Co.
J. H. Sanford, Ohio Brass Co.
W. C. Schott, Stonega Coke & Coal Co.
T. Reed Scollon, U. S. Bureau of Mines
Chester G. Sensenich, Irwin-Sensenich Corp.
W. J. Shields, Rochester & Pittsburgh Coal Co.
William B. Stephenson, Allen-Sherman-Hoff Pump Co.
W. G. Talman, U. S. Steel Corp.
Laurence E. Tierney, Jr., Eastern Coal Corp.
George C. Trevorrow, Bituminous Coal Operators' Association
W. L. Wearly, Joy Manufacturing Co.
C. C. White, Penn-Birmingham Bolt Co.
M. A. Williams, Oglebay Norton Co.
Richard Wright, Penn Machine Co.
James A. Younkins, Duquesne Light Co.

NEWS and views

Kerr-McGee to Become Potash Producer in Joint Venture

Kerr-McGee Oil Industries, Inc. and National Farmers Union Service Corp. are forming a new company to mine and mill extensive potash reserves near Carlsbad, N. M. The new enterprise, Kermac Potash Co., will be a partnership in which a wholly-owned subsidiary of each parent company will have a 50 percent interest.

A large-scale pilot plant program is being launched immediately at Kerr-McGee's metallurgical research laboratory at Golden, Colo., to finalize engineering and design plans and specifications for a 1500-tpd potash plant on which construction is to be started at the earliest possible date. Kerr-McGee will be operating partner for all phases of the venture.

Kerr-McGee's recently issued annual report tells of plans for modifying Kermac Nuclear's Lakeview, Ore., uranium plant to permit the treatment of ferrophosphorous slag for the recovery of high-purity vanadium. The Lakeview plant, which was acquired by Kermac from Lakeview Mining Co., utilizes the acid leach solvent extraction process for treating uranium ores.

Underground Safety Campaign Set

A Campaign to Prevent Injuries from Falls of Ground in Mines will be conducted by the National Safety Council beginning January 1, 1962 and ending December 31, 1962. Goal of the campaign is a 50 percent—or better—reduction in the frequency rate of injuries from falls of ground.

The campaign is sponsored by the Mining Section of the Safety Council under the direction of an Advisory Committee composed of Al Kolu, Pickands Mather & Co., chairman; Edward C. Leonard, Inland Steel Co.; and John A. Cooke, Falconbridge Nickel Mines, Ltd. Endorsing and cooperating in it are Federal, State, and provincial mining departments, mining associations, mining publications, insurance carriers, and others having an interest in the welfare of the mining industry.

All underground mines, excluding coal, are urged to participate in the campaign. This includes mining companies in Canada and other countries outside the continental United States. Membership in the Mining Section of the National Safety Council is not required.

Enters Industrial Minerals Field

Callahan Mining Corp. has taken over the operation of a group of 16 nonmetallic mining properties and affiliated processing plants of Huntley Industrial Minerals, Inc., Bishop, Calif. Of the 16 properties, 13 are located within 60 miles of Bishop, and three are in Nevada. They contain a variety of nonmetallic ores including major deposits of kaolin and talc and deposits of white limestone, siltex, garnet, soft white silica, magnesium clay and pyrophyllite. Six of the Huntley mines are currently in operation, while exploration and development at the remainder either proved out or indicated substantial ore deposits.

Callahan Mining has formed a new division, Callahan Industrial Minerals Co. to operate the mines and plants.

Options Mine Properties

Bunker Hill Co. has taken purchase options on three mining properties, identified as the Bonanza, Old Dominion, and Clugston Creek, in Stevens County, Washington. The company is investigating each property and currently is test drilling at the Bonanza, which has a 45 year lead-silver production record dating to 1907. It yielded 102,000 tons of ore from which 12,000 tons of lead and 238,000 oz of silver were taken. The Dominion property produced some high grade silver ore and the Clugston Creek property is known to have yielded iron and lead ores. Other developments in the company include the resumption of exploratory drifting on the 790-ft bottom level of the Nancy Lee mine in Montana. Present plans call for sinking the shaft 400 ft below the present bottom level. Bunker Hill has a 25-year lease on the Nancy Lee.

Sabre-Pinion Buys Interest in Uranium Mill

Sabre-Pinion Corp. has purchased the interests of Hidden Splendor Mining Co. in the Homestake-New Mexico Partners uranium processing mill at Grants, N. M. Sabre-Pinion also acquired the Dysart No. 2 mine and other mining properties in the transaction. Hidden Splendor plans to use funds generated from the sale to further diversify its activities into beryllium, gas and oil, uranium and asbestos. The company retains some of its New Mexico holdings and will continue as a uranium producer there.

In another development, Sabre-Pinion and United Nuclear Corp. propose to combine the assets and business of the two companies through an exchange of stock. The proposal is subject to stockholder approval. United Nuclear is a nuclear fuel and reactor core producer and reactor designer.

Phosphate Development Project Announced

International Minerals & Chemical Corp. and Husky Oil Co. have reached an agreement for developing phosphate reserves at Soda Springs, Idaho. Owned by Husky, the reserves are estimated at 50,000,000 tons and are said to be among the largest known reserves of surface mineable phosphate ore in the United States. International Minerals recently sold industrial grade phosphate reserves in Tennessee and will concentrate on production in Eastern United States from its extensive operations in Florida.

The agreement between IMC and Husky allows up to five years for development of a final plan for undertaking the joint venture. In the event that Husky should, for any reason, decide to not enter the project, the agreement provides an equitable basis for sale of the deposits to IMC.

Non-Explosive Rock Breaking Achieved

Working in cooperation with Montana School of Mines under a research grant from The Anaconda Co., General Electric Co. reveals that a non-explosive process for breaking rock with radio-frequency electrical power has been achieved. Known as electrothermal forcing, the method relies on creation of a current conducting path through the rock by means of electrodes which apply high energy radio-frequency power to it. Once established the conducting path makes it possible to pass high energy d-c power between the electrodes which creates sufficient heat or thermal stress to split the rock.

The process, in addition to being dustless, is said to be fast, simple, requires only routine safety precautions and no evacuation of personnel. According to the company, the method will be more economical than secondary breaking with explosives, and will be applicable both to underground and open pit operations. It is said that the process can be used on metal-bearing ores as well as on rock materials, such as granite, which are normally considered non-conductors. The time required for breakage (varying from a few seconds to a few minutes) depends on the rock size and method of applying current. [Ed. note: See MCJ, May 1961, pp. 53–55, "Dustless Breaking of Rocks Electrically."]

Colorado Coal Mine Purchased by P & M

Pittsburgh & Midway Coal Mining Co. has purchased the Edna mine of Edna Coal Co., located in Routt County, near Steamboat Springs, Colo. The acquisition was made to expand the company's coal mining and production reserves in Colorado. It is expected that the mine will extend P&M's mining activities in Colorado 30 or more years. For the past 11 years, the company has operated the Osage mine, which is also near Steamboat Springs.

The Edna mine is located at an elevation of 8000 ft and is said to be the highest strip mine in the United States. A 2400-ft conveyor belt that drops 700 ft carries coal from the mine to the preparation plant. The mine is operated year-round despite temperatures as low as 40° below zero and annual snowfalls of over 150 in. With the new property, the company plans to produce about 600,000 tons per year from its Colorado mines.

ALSO . . .

Use of mill tailings for road fill is being studied by the Utah Department of Highways, following suggestions of engineers from Kennecott Copper Corp. The tailings would be used on a new highway that would require between 90 and 150 million cu yd of fill. The tailings would be piped to the proposed road project from Kennecott's Arthur and Magna mills. Kennecott engineers estimate that delivery costs would range from five to six cents per cubic yard, which is about one-seventh to one-twelfth the cost of dirt fill that might otherwise be used on the project.

The Pacific Northwest Regional Minerals and Metals Conference will be held April 26–28 in Seattle, Wash. Eight sessions, covering mining geology, mineral benefication, industrial minerals, and extractive and physical metallurgy are planned.

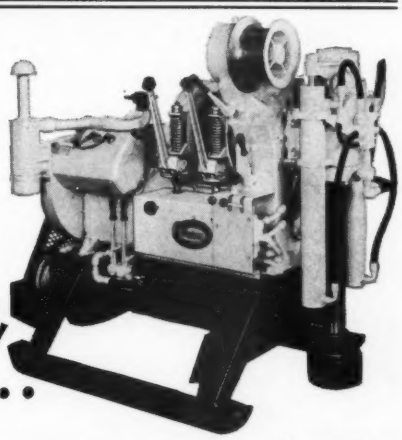
A pipeline for transporting coal from Carbon County, Utah, to the Pacific Coast is reportedly under discussion by Heiner Coal Co. and Pennsylvania interests.

A contract calling for exploration of a copper-cobalt deposit in Lemhi County, Idaho, has been executed between the Office of Minerals Exploration and Idaho Copper Mines, Inc. Under the contract, the company is authorized to spend $88,030, half of which will be borne by the Government.

(continued on page 98)

IT'S A FACT

NEW Longyear "38" Drill works anywhere, goes anywhere . . .



ALL THE FEATURES drillers have asked for are combined in the new Longyear "38" Diamond Drill. Finger-tip controls and a wide range of optional equipment put the operator in complete command. Ideal for all kinds of mineral exploration jobs, blast hole drilling and site development work. The versatile "38" has new low-range speeds, optional built-in Wire Line Hoist and hydraulic retraction. Features compact design with lightweight chassis breakdown for easier transporting. Capacity, 2800 ft. with AW rods. For information, contact our nearest office.

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(continued from page 97)

Clayton Silver Mines expects to increase its mill capacity from 100 to 150 tpd. The company operates the Clayton lead-zinc-silver mine at Clayton, Idaho. Development work at the mine has revealed a larger ore body at depth containing higher silver values than the upper workings.

Anaconda Co. is expanding its western Montana lumbering operations into an integrated logging, milling, fabricating and selling organization to be known as Anaconda Forest Products. The company expects to create one of the largest forest product organizations in the northwest with this new endeavor, which calls for modernization of its sawmill at Bonner, Mont., and erection of facilities for processing lumber into consumer products.

A 100 tpd sulphur producing plant will be built at Sulphurdale in Beaver County, Utah, according to plans of Sulphurdale Chemical Co. The mill, expected to cost about $250,000, will process by flotation methods sulphur bearing ores from a 1600 acre tract at Sulphurdale. Known reserves at the property amount to about 1,000,000 tons containing from 30 to 70 percent sulphur.

A 10 tpd pilot plant for processing beryllium ores from the Spors Mountain area of Utah will be built at Salt Lake City according to plans of Vitro Minerals Corp. The mill will not be constructed until settlement of legal matters concerned with mining claims at the Spors Mountain deposits.

Exploration at the Questa, N. M., molybdenum property of Molybdenum Corp. of America is reported progressing satisfactorily. Work done prior to June 1960 had disclosed a large area of molybdenum mineralization at the property. Since then the company has been concentrating its exploration work in two areas of favorable mineralization as indicated by drill hole and tunnel assays. Assays from the south area show molybdenum mineralization with a grade of 0.3 percent to 0.4 percent MoS_2, while assays in the northeast area are reported higher. Current work is being conducted to establish the feasibility of a commercial operation in the enriched areas. The company has in recent months acquired additional ground and now holds about 20 sq miles at Questa. It intends to extend its exploration to favorable portions of the new area.

A workshop and symposium on computers and computer applications to mining and exploration will be held at the University of Arizona, Tucson, March 26–30, 1962, in cooperation with Stanford University. Workshop subjects to be covered include an introduction to computers, programming and mathematical techniques and general computer applications. The symposium part of the meeting will be concerned with applications in mine development, mine design, production scheduling, equipment analysis, quality control, regional reconnaissance, district investigation and deposit evaluation.

Development work by Goldfield Consolidated Mines Co. at Getchell Mine, Inc., Humboldt County, Nevada, has led to plans for mining and milling a new gold ore body at the property. The company expects to mine the deposit by open pit methods.

Dollar for dollar
in cost of cutting,
Bowdil Bits
OUTPERFORM
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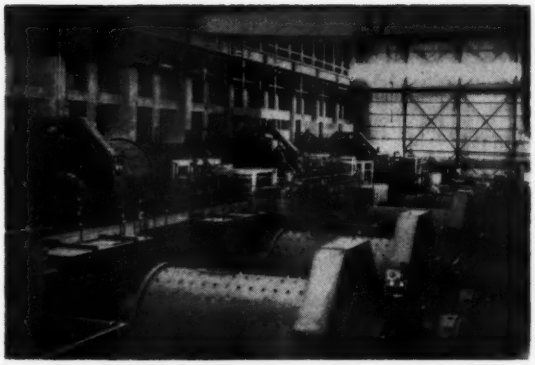

Grinding section of the Mission copper concentrator of American Smelting & Refining Co. Designed to treat an average of 15,000 tpd of ore, the mill will annually produce approximately 165,000 tons of copper concentrates containing 45,000 tons of copper. Concentrates will be smelted at the company's Hayden, Ariz., and El Paso, Texas, plants. The Mission Unit began operations August 1, eight years following optioning of the property

A work-study program in mining engineering will be offered through three Pacific Northwest universities—the Universities of Washington and Idaho and Washington State University. The plan offers students opportunities to gain experiences and knowledge of mining operations before graduation and to earn part of their school expenses. Under the plan teams of two students will work in mines on alternate successive six-month periods. Mining companies that will cooperate in the program include Bunker Hill Co., Sunshine Mining Co., Hecla Mining Co., Pend Oreille Mines & Metals Co., and American Smelting & Refining Co.

An extensive gypsum deposit is reported to have been discovered by English Oil Co. while attempting to develop natural gas deposits in Emery County, Utah. The company and others have staked and leased 15,000 acres to cover the gypsum deposits, which are said to be of "remarkable thickness, purity and areal extent."

A plan to explore properties of Mammoth Mining Co. near Eureka, Utah, is under consideration by New Park Mining Co. and East Utah Mining Co. The work would cover 700 acres of claims and involve exploration from the 2300-ft mine shaft at the Mammoth, a gold, silver, lead, zinc, copper property.

STATEMENT, REQUIRED BY THE ACT OF AUGUST 24, 1912, as amended by the acts of March 3, 1933, July 2, 1946 and June 11, 1960 (74 Stat. 208) showing the ownership, management, and circulation of MINING CONGRESS JOURNAL, published monthly at Washington, D. C. and Lancaster, Pennsylvania, for October 1, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business manager are:
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Managing Editor, George W. Sall, Washington, D. C.
Business Manager, P. D. McMurrer, Washington, D. C.

2. The owner is: The American Mining Congress, a corporation not for profit, Washington, D. C. No stockholders, President, Raymond E. Salvati, Huntington, West Virginia; Executive Vice-President, Julian D. Conover, Washington, D. C.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

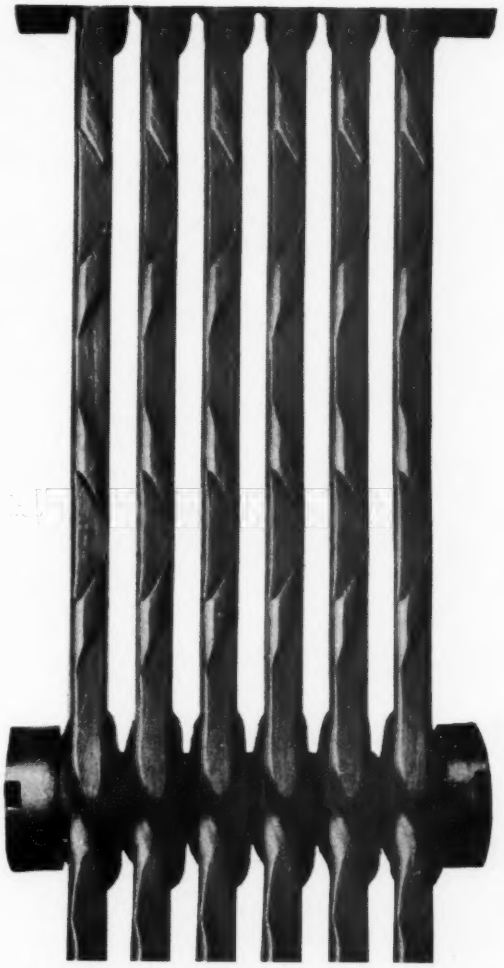
4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 16,818.

ROBERT W. VAN EVERA,
Editor.

Sworn to and subscribed before me this 28th day of August, 1961.
HARRIS HAVARD,
Notary Public.

(My commission expires March 14, 1963.)



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Wedge Wire Screen with a riffle on top!

Combines the best features of flat-top and conical-top wedge wire screens. Riffle Top profile bar provides greater draining capacity without loss of mechanical or lateral strength. Riffle markings on the upper surface of the wedge wire guide fluids to openings, lift over-size particles above the screen's opening level and reduce wear. Other advantages include rugged construction for longer life and extra load carrying capacity, free clearance and large open area.

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Why Yieldable Arches are so effective in control of spalling roofs

Steel *for Strength . . . Economy . . . Versatility*

In a large coal mine in West Virginia, the immediate roof is bone coal, slate, sandstone, sandy shale, and other materials difficult to control. During mining operations these overlying strata often broke off and fell into the workings.

Bethlehem's Yieldable Arch provided the most dependable and economical answer, because it was designed to "give" under extreme pressures and impacts. Lagging and packing around the Arches catch the falls as they occur, and transfer the load to the steel arch sets. The Arches yield a little at a time as pressure builds up, thus allowing the roof to arch over and stabilize itself.

A Yieldable Arch set consists of U-shaped segments which are heavily flanged to resist torsional stresses. The segments lap each other at the ends, where they are secured with pairs of husky U-bolt clamps to provide a friction joint. When loads overcome the friction the Arch yields gradually to relieve the pressure, at the same time giving the overburden a chance to establish equilibrium.

Many mines have discovered that Yieldable Arch installations pay for themselves in a matter of months. A Bethlehem engineer will welcome the chance to discuss with you the advantages of Yieldable Arches in your mine.

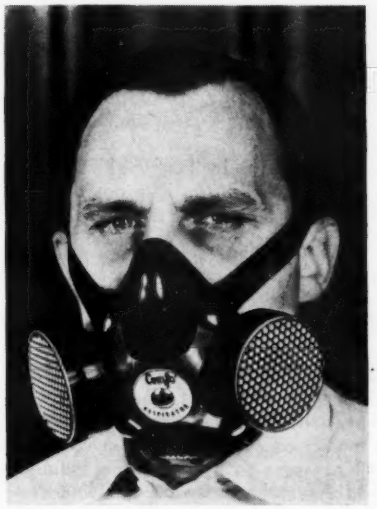
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

manufacturers forum

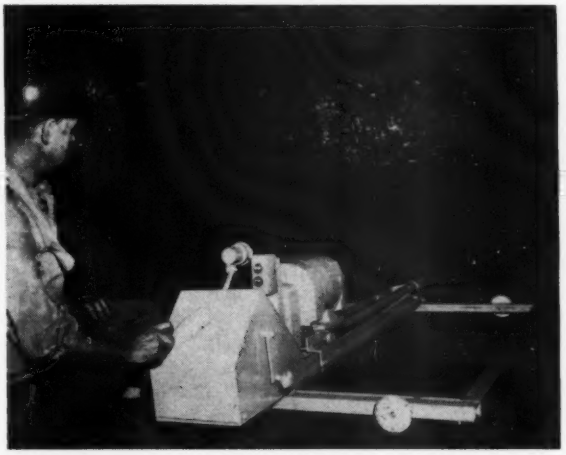
A REDESIGNED CUSTOM RESPIRATOR, known as Comfo, from Mine Safety Appliances Co. features an improved facepiece peripheral seal which provides for a greater range of facial shapes and sizes by including



an inturned lip and deep chin cup cushion supported by a four-point floating suspension system. This minimizes the need for a full facepiece in areas of "nuisance" concentrations of contaminants or toxic dusts. Approved by the U. S. Bureau of Mines, the half mask is also employed as a component part of similar dust, chemical cartridge, and air line respirators.

AIR COOLED STATIONARY COMPRESSORS designed to deliver from 200 to 600 cfm of air at 250 psi have been developed in a new series by LeRoi Div., Westinghouse Air Brake Co., Sidney, Ohio. The rating is supplied by three and six cylinder versions of two basic models. The three cylinder 253 "S2" delivers 200 to 275 cfm through a single high compression head from a power take-off or separate engine drive. The six cylinder 256 "S2" produces 400 to 600 cfm depending on speed selected. Air is compressed to 60 psi in the first stage of the compression cycle and discharged at 250 psi from the high pressure cylinders in the second stage.

DETAILS OF A ONE-MAN COAL CUTTING MACHINE have been announced by Sherman G. Martin, of Dunbar, Pa., manufacturer of the prototype machine.

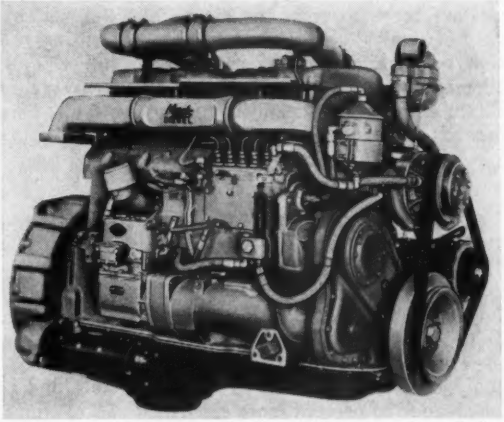


The machine weighs less than 200 lb and is built on a square tubular frame which is five ft long and less than four ft wide. An electric motor, mounted by rack-and-pinion on the tubular frame, drives a carbide-tipped auger bit through a cylindrical jacket into the coal face. By indexing the auger location in a series of positions laterally along the rack, the machine operator is able to drill a series of holes in a straight row so as to undercut the entire coal face. The coal can be made to fall away quickly into the undercut with a small dynamite blast from above.

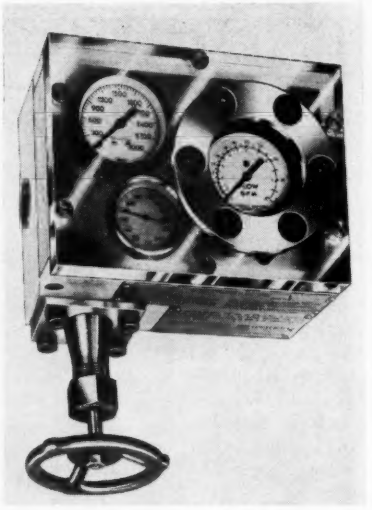
The machine is 16 in. high and can be operated in coal as low as 20 in. The new machine is expected to find wide use in very small mines owned and operated by individuals in their spare time. It is to be marketed by the newly formed Mighty Miner Company, a division of Shallway Corporation of Connellsville, Pa.

TWO TUNGSTEN CARBIDE MINING BITS have been newly designed by Carmet, a division of Allegheny Ludlum Steel Corp., Pittsburgh, Pa. The bits are designated as RS, a single point cutter bit with a bottom notched shank for use with quick change keepers, and AP, an all-purpose coal drill bit available in 1¾ in. and 1⅞ in. sizes with an eccentric carbide tip to give extra fast penetration.

HORSEPOWER INCREASE through a new air intake principle is mentioned by Mack Trucks, Inc., Plainfield, N. J., as an important factor in the development of the PowerRam Thermodyne engine, an improved version of their naturally aspirated Thermodyne diesel engine. This development has taken place without appreciable increase in engine weight. The new intake principle increases volumetric efficiency by 10 percent, and improves the breathing capacity of the engine. In addition, torque output is improved.



TO PINPOINT HYDRAULIC SYSTEM PROBLEMS in a matter of minutes a portable instrument has been developed by Schroeder Brothers Corp., McKees Rocks, Pa., for on-the-job use wherever hydraulics (up to 3000 psi) are employed. Possible applications are on light and heavy industrial equipment, mining, light and heavy construction machinery. Weighing only 20 lb, the Schroeder Hydra-Sleuth incorporates flow, pressure, temperature gauges, and a load-valve for use in any position on hydraulic equipment. The instrument case measures 5 ft by 6 ft by 8 ft. A high strength aluminum block serves as case and manifold for gauge porting and mounting. A heavy plexiglas cover protects gauges from external damage, and the steel load valve stem and hand wheel serves as a convenient carrying handle. A built-in safety blowout plug protects both the Hydra-Sleuth and the system on which it is used from overloads. Flow gauge of the instrument reads directly in gallons per minute, with two scale ranges: 0 to 10 gpm, and 6 to 30 gpm. The pressure gauge indicates loads up to 3000 psi and the temperature gauge records from 20 to 240° F.



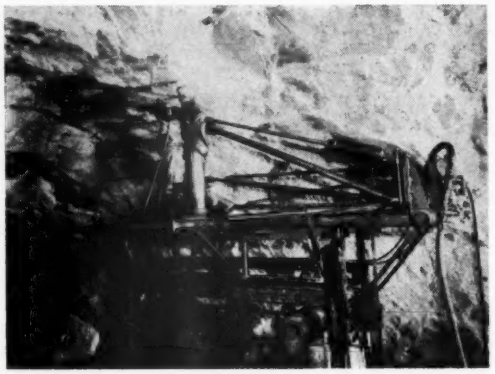
AN EIGHT-CYLINDER, VALVE-IN-HEAD UNIT, the UV-345, has been added to the engine line of International Harvester Company's Construction Equipment Div., Chicago. It has a stripped engine rating of 194 hp at 3800 rpm, industrial engine rating of 164 hp at 3000 rpm and industrial engine (with fan) rating of 158 hp at 3000 rpm, fueling with gasoline. Leading features of the U-345, resulting in quiet, responsive power, are rigid "Y" block, Tocco-hardened crankshaft, aluminum alloy pistons and positive-type exhaust valve rotators. Bore and stroke are 3⅞ in. and 3-21/32 in. Piston displacement is 345 cu in. Compression ratio is 8.05:1.

There is a full-pressure lubrication and full-flow oil filtering. Cooling capacity, including radiator, is 29 qts and lubricating system, including filters, is seven qts. The UV-345 is 39½ in. high, 33½ in. long, 38½ in. wide and weighs 740 lb. The engine soon will be available for natural gas and LPG fueling.

FOR MOUTH-TO-MOUTH RESUSCITATION, A NEW COMPACT, LIGHTWEIGHT ADJUNCT called the MSco Rescue Breather, is announced by Medical Supply Co., Rockford, Ill. Small enough to be carried in the rescuer's pocket, purse, auto compartment, or first aid kit, the MSco Rescue Breather features a flexible, tightly fitting facepiece for all faces and configurations, child or adult.

As reported by the maker, this new adjunct is simple to use and can be operated with complete safety because it extends only one in. into the victim's mouth and cannot stimulate the gag reflex. Its specially designed bit block can be wedged between the victim's teeth to open the mouth in case of jaw spasm. Ratchet indentations on the bite block prevent it from slipping out of position. There are no valves or moving parts and the equipment is easily cleaned and sterilized.

A NINE FT RETRACTABLE AIR LEG has been announced by Machinery Center, Inc., Salt Lake City, Utah. The "Long Tom" consists of a balancing air cylinder and an extendable air cylinder. By adjusting a four way pressure valve, which regulates air in the balancing cylinder, air instead of man power supports the rock drill whether retracted—partially extended—or extended the full nine ft. The extendable air cylinder maintains the drill point in constant contact with the ore. By adjusting the air pressure to the balancing cylinder the drill is held at any desired height, and movement up or down is accomplished by pushing down or lifting the leg (with one hand) to the new position. The "Long Tom" is equipped with a specially designed "Goose Neck" which allows positioning of the drill to any angle. The operator does not have to hold the machine when drilling neat line on the rib holes or angling the drill for cut holes. The drill can be crawler, rail, or tire mounted and can be single or multiple deck rigged.



FOUR-WHEEL-DRIVE TRACTOR SHOVELS, a new improved series "B" version, the H-30 "Payloader," has just been announced by the Frank G. Hough Co., Libertyville, Ill. This unit, although still the smallest in their four-wheel-drive line, is now equipped with a 1¼-cu-yd bucket, which adds 25 percent more capacity. Balance and stability of the original H-30 have been retained, according to the manufacturer.

From a safety angle, the boom arms are positioned ahead of, and away from the operator; there is a walk-in operator compartment; new hand rails and safety ladder; adjustable bucket seat; new transmission controls, and a steeply sloped cowl, with no operator visibility obstructions to right or left. Four-wheel hydraulic brakes give equal braking in both forward and reverse. Dual foot brake pedals give the operator a choice of braking with or without transmission engaged. Both axles are equipped with torque-proportioning differentials.

Retained is the Hough-designed and built "Paylomatic" full power-shift transmission, which is a full-reversing, constant-mesh, countershaft-type with balanced, rotating hydraulic clutches.

COMPACTNESS AND LIGHT-WEIGHT are the predominant features of the new portable engine

generator AGA Model C 869-3T from AGA Corp. of America, South Plainfield, N. J. The set weighs 40 lb, is 15 in. long by 15 in. wide by 11 in. high, and is rated at 300 watts, 115 volts, 60 cycle, 1 phase. The company has produced the generator for use with its geodimeter, but it can be used under any conditions where portable equipment of this type is needed. It has a two-cycle, 1-cylinder Clinton gasoline engine rated at 3600 rpm and has an adjustable pneumatic type governor.

A NEW ROOF BIT AND DRILL STEEL COMBINATION has been designed by the Mining Tool Div. of Kennametal Inc., Bedford, Pa., for maximum dust removal without loss of drilling speed. The drill steels feature heat-treated prefabricated chucks and shanks, permitting the attainment of strong metallurgical properties in these components which, otherwise, would not be possible. A second feature of the half-inch square chuck is an integral collar that traps the dust in the slotted section above it, through which the dust is drawn into the hollow drill steel. Another design improvement locates the pin holes at right angles to the dust removal slots so that the pin that holds the bit cannot obstruct the flow of dust or cuttings.

The shorter shank and body design of the FVH bit minimizes the distance between the point of penetration and the vacuum slots, to assure a short, smooth, fast flow of cuttings into the hollow steel. The carbide insert's flat bearing surface gives it more support and improved resistance to breakage. A variety of drivers and extensions of similar construction is available for use with the FVH bit.

—ANNOUNCEMENTS—

J. J. Davis has been elected to the presidency of **Esco Corp.** with **Newman Ward,** former president, becoming chairman of the board of directors. **C. F. Swigert, Jr.,** becomes honorary board chairman.

J. J. Davis

Davis has been with Esco for 25 years, joining the firm in its Seattle sales district as office manager. He later served as a district sales manager and as manager of the Logging, Sawmill, Crushing and Construction Equipment Divisions in Portland. In 1954 he was promoted to vice president in charge of product divisions, and in 1959 became executive vice president.

Ward, who started with the company in 1916, was vice president and general manager before becoming president in 1952.

The Koehring Co. has elected **Orville R. Mertz,** financial vice president and treasurer, to the board of directors. Mertz joined the company in 1953 as controller, and came to his present position two years later. Before joining Koehring, he had extensive accounting experience with both industrial and educational organizations.

Cummins Engine Co. has announced the appointment of **Marion C. Dietrich** as director-sales (parts and special products) and member of the company's executive committee. Dietrich will be responsible for parts sales and distribution, and special product sales of the company's domestic subsidiaries.

The Colorado Fuel & Iron Corp. has announced the election of two new vice presidents. **R. L. Hanes** will be in charge of sales of the company's Western Division, and **E. George Hartmann** will be in charge of sales for the **Wickwire Spencer Steel** and **John A. Roebling's Sons Divisions.**

Hanes last two positions with the company were as general manager of tubular sales and as assistant to the vice president of sales. Hartmann had been serving as Roebling's vice president of sales.

Maxwell L. McCormack is now a vice president of Ingersoll-Rand Co. He was formerly on the company's executive staff and was promoted to his new post at the same time that **D. Wayne Hallstein** and **Jacob J. Jansen** became executive vice presidents and **Herbert Cresswell, David C. Garfield, John G. Lutz, E. Raymond Sheerin and Joseph A. Wiendl** were elected to vice presidencies. McCormack has been active for many years in the American Mining Congress and for about 20 years has been on the board of governors of the organization's Manufacturers Division.

John W. Thornton, formerly vice president-marketing of **Joy Mfg. Co.,** has been elected vice president and general manager of the company's Industrial Division.

Joy also has announced the promotion of four men within its coal Machinery Division. **R. R. Fenner** has been transferred to Carlsbad, N. M., to be assistant district manager of the Denver Coal Division office; **Frank Muro** has been appointed chief engineer of conveyors at the Franklin, Pa., plant; **John H. Fleming** has been appointed technical service manager at Franklin; and **Wendell Baker,** has become supervisor of the order service department at Franklin.

John P. Cartwright has been named vice president, machinery group, of **Dresser Industries, Inc.** He was formerly a divisional vice president and general manager of Joy Mfg. Co.

Patrick L. McManus, formerly director of marketing services of **Worthington Corp.,** has been appointed general manager of the company's Standard Pump Division, located at East Orange, N. J. He has served the company since 1936 in various sales positions.

(Catalogs & Bulletins next page)

CATALOGS & BULLETINS

FINE SCREEN. *Dorr-Oliver, Inc., Stamford, Conn.* The design and operation of the D–O 270° DSM screen, especially adapted for operation in grinding of cement raw mix, is described in leaflet #2300-A. When used in a raw cement grinding circuit, the screen provides increased mill output and over-all reduction in power consumption. Users in Australia also report improved burnability, because virtually all tramp and plus 48-mesh material is removed from the kiln feed.

ROTARY BLAST–HOLE DRILL. *Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.* The 60-BH Champion Drill, an electrically powered rotary blast-hole drill for drilling large holes in hard rock, is described in bulletin B-39N. Shown are performance features, field illustrations, and general specifications. The Champions are rated for 9 to 12¼ in. holes, and are available for either off-the-end or through-the-center drilling, depending on mine conditions.

SUSPENDED MAGNET. *Stearns Magnetic Products, 635 S. 28th St., Milwaukee 46, Wis.* Bulletin No. 1032 describes the completely new line of Stearns oil-filled suspended separation magnets, plus information on the use of automatic tramp iron removal assemblies, such as the in-line automatic suspended magnet and the cross-belt automatic suspended magnet, and the proper areas for use of each of these types.

WELDING HANDBOOK. *Alloy-Rods Co., P. O. Box 1828, York, Pa.* "Handbook for Welding Low Alloy High Tensile Steels" is a 64-page reference volume which contains physical properties and analysis and pertinent welding information on many trade name steels. It gives electrode recommendations for the welding of each of these trade name steels, as well as for hundreds of steels produced to ASTM specifications. The handbook is intended as a reference guide for the maintenance man faced with these welding applications.

A–C MOTORS. *The Leland-Ohio Electric Co., 1501 Webster St., Dayton 1, Ohio.* A line of integral-small hp, explosion-proof a-c motors is described in the company's bulletin 1000, CD. The motors ranging from one through five hp are for operation on power supply of all standard voltages and frequencies, single or polyphase.

LIQUID OXYGEN CYLINDER. *Linde Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17, N. Y.* A liquid oxygen cylinder with a capacity of 3000 cu ft of oxygen is described in Booklet F-1258. The large capacity Linde LC-3 cylinder supplies the equivalent of 12 "K" type high-pressure cylinders, yet weighs only 463 lb, and requires only 1/3 the space in storage or operation as its equivalent in high-pressure cylinders. The compact LC-3 delivers 300 cu ft of oxygen per hr at pressures up to 75 psi.

SNOW MOVERS. *Advertising Div., Caterpillar Tractor Co., Peoria, Ill.* A new booklet, form D119, covers machinery available for the season that is not far off. The versatility of Caterpillar Motor Graders, using V-plows and wings, reversible plows, one-way plows and loaders is described. The role of Caterpillar wheel loaders in moving snow is explained, pointing to the features of front dumping or side bucket dumping. Uses of a rotary or conventional plow are identified at the places of actual usage.

FREQUENCY VIBRATING CONVEYORS. *Stephens-Adamson Mfg. Co., Aurora, Ill.* Bulletin 361 describes the new natural frequency vibrating conveyors with exclusive variable stroke positive drive, developed by Stephens-Adamson. The new conveyors have a variable stroke positive drive that provides infinitely variable conveying speeds from zero to maximum. Conveying speeds are controlled accurately regardless of conveyor length or capacity handled, and can be changed even while the conveyor is in operation. The new conveyors are ideal for varying retention time in drying, cooling, de-watering, and similar applications, and in many instances the conveyor can serve as a feeder, reducing the amount of equipment needed.

REPLACEMENT PARTS. *The S. K. Wellman Company, 200 Egbert Road, Bedford, Ohio.* A new series of service bulletins are available from the company. Subjects of the first 3 issues are (1) riveting of metallic blocks or facings; (2) circle grinding of Velvetouch Feramic truck brake blocks; and (3) copper steering brake block sets. The Bulletins discuss latest product developments, proper application methods and present numerous maintenance hints. They deal with installations in motor trucks, mining machinery, and industrial equipment.

ENGINEERING SUMMARY. *The Eimco Corp., P. O. Box 300, Salt Lake City 10, Utah.* Eimco Corp. has available a limited supply of reprints of the engineering summary written by Loraine Gold Mines, Ltd. of a record-making drift development in Africa. The 18-page engineering summary includes ten detailed drawings, full descriptions of headings; water control, working procedures; ventilation, maintenance and performance achievements, utilizing the Eimco 40 track-mounted loaders which were used in each heading.

Index to Advertisers

American Air Surveys, 90
American Oil Co., 18–19
American Steel & Wire Div., 28–29
U. S. Steel Corp.
Anaconda Wire & Cable Co., 94

Bethlehem Steel Co., 100
Bowdil Company, 98

Caterpillar Tractor Co., 32
Centrifugal & Mechanical Industries, Inc., 24

Deister Concentrator Co., 89
Denver Equipment Co., Inside Front Cover

Euclid Division, 7
General Motors Corp.

Gerow, Theron G., 90

H&L Tooth Co., 23
Hendrick Mfg. Co., 99
Hendrix Mfg. Co., 16
Heyl & Patterson, 2

Jeffrey Mfg. Co., 51
Joy Mfg. Co., 13

Kennametal, Inc., Inside Back Cover

Lee-Norse Co., 15
LeTourneau-Westinghouse Co., 25, 26–27
Long-Airdox Co., 8–9
Longyear Co., E. J., 66, 90, 97

Mack Trucks, Inc., 86–87
Macwhyte Wire Rope Co., 22
Marion Power Shovel Co., 11
Mine Safety Appliances Co., Back Cover
Mining Progress, Inc., 6
Mott Core Drilling Co., 90

National Electric Coil Div., 12
McGraw-Edison Co.
National Mine Service Co., 17

Ohio Brass Co., 4

Pattin Mfg. Co., 91

Raybestos-Manhattan, Inc., 30–31
Manhattan Rubber Div.
Roebling's Sons Div., John A., 14
The Colorado Fuel & Iron Corp.

Sanford-Day Iron Works, 70
Stearns-Roger Mfg. Co., 47
Stratoflex, Inc., 10

Union Wire Rope Corp., 92–93
U. S. Rubber Company, 20–21
U. S. Steel Corp., 28–29
American Steel & Wire Div.
Columbia-Geneva Steel Div.
Tennessee Coal & Iron Div.
United States Steel Export Div.

Woomer & Associates, J. W., 90

new...KENNAMETAL U21 BIT

dual gage shoulder design
... plus new achievement in dimensional control

Rigid dimensional control is the most important feature of the new Kennametal U21 Cutter Bit. Here's why:

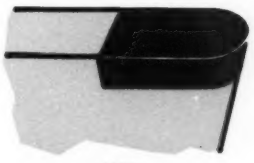
• **CLOSER TOLERANCES** assure a tighter fit and provide greater stability of the bit in the block. This, in turn, means less "pounding" or deformation of the tool holder, and less flexing of the rubber keeper with resultant longer life. Firm positioning against the work provides more positive cutting action.

• **DUAL GAGE SHOULDERS** provide front and rear bearing areas to absorb the shock forces encountered in severe cutting conditions.

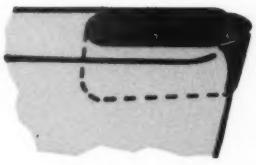
• **PULL-OUT NOTCH,** replacing the pull-out shoulder, is located to permit easier, safer extraction of tools from blocks on ripper-type chains. Bits are removed quickly . . . which saves you time and money.

Now's the time to prove, in your mine, how the new dual shoulder, quick-change Kennametal U21 will stand up under the most rugged cutting conditions. Let the Kennametal difference in quality and design show up in performance—more production—greater profits. Call your Kennametal representative or contact us direct. KENNAMETAL INC., Mining Tool Division, Bedford, Pennsylvania. Phone 623-5134.

The new U21 Cutter Bit is available in three standard tip styles. Ordering designations are U21RA, U21R, and U21. 34225



U21



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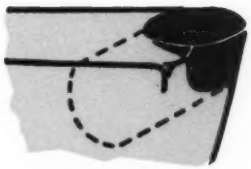


U21RA

U21
Full Nose Radius Style

U21R
Recessed or Channel Style

U21RA
Cylindrical Plug Style

KENNAMETAL
...Partners in Progress

NEW Completely Transistorized M-S-A® Model E-60 MinePhone®

Here's the first mine communications system fully protected against power failure

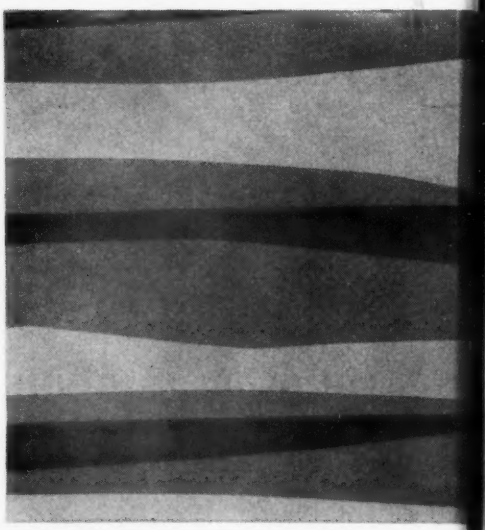
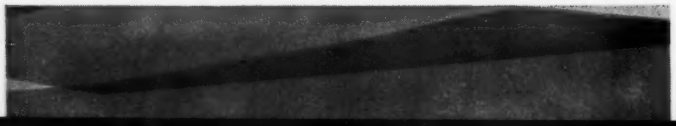
Power failures can't knock out the rugged M-S-A E-60 MinePhone.

Always operative, power comes from the storage battery, on constant charge from the trolley. Takes only *one watt* of battery energy to ready the MinePhone for standby transmission or reception. In event of power failure, you still have hours of service from the fully charged battery. As power is restored, battery is automatically recharged.

The compact transistor makes possible a 35% reduction in size of this new transmitter/receiver. There are no vacuum tubes to wear out. No damage due to vibrations.

Consider these safety factors: the E-60 MinePhone — needing no warm-up period — permits instant reporting of hazardous mine conditions. Scheduling is more efficient. And in case of emergency you can alert both surface and mine personnel — keep them tuned in — even when trolley power is off.

You can realize an impressive pick-up of movements from face to tipple, too. More trips per shift without costly traffic tie-ups. Improved control and distribution of mobile equipment. No unnecessary starting and stopping.

Your MSA representative would be pleased to discuss your actual communication requirements. Call him soon. And write us for free product data bulletin. Mine Safety Appliances Company, Pittsburgh 8, Pennsylvania. In Canada: Mine Safety Appliances Company of Canada, Ltd., 500 MacPherson Avenue, Toronto 4, Ontario.

MINE SAFETY APPLIANCES COMPANY MSA